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Objective Chances in a Deterministic World

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ABSTRACT

Determinism is the thesis that the state of the world at any time uniquely determines the state of the world at all future times. Our best scientific theories seem inconclusive as to whether our world is deterministic. Our world could very well be either partially or completely deterministic. But determinism is not as innocuous as it seems; the truth of determinism seems to come into conflict with many intuitive concepts. One such concept is objective chance. Our intuitive notions of objective chances are tied to the belief that events could have turned out differently than the way they actually occurred. Though many philosophers have declared that this conception of objective chance is incompatible with deterministic worlds, some have tried to provide accounts that render the two compatible. In this thesis I investigate what a theory of deterministic chance could be. Working within certain metaphysical constraints on chance, I craft out a new dispositional account of chance grounded in properties that objects have.

ACKNOWLEDGEMENTS

My first philosophy course came in the first semester of my sophomore year. It was a 9:20 class on the philosophy of mind taught by Lauren Ashwell. Previous to Professor Ashwell's course I had no experience with metaphysics. The course started out roughly, not in the sense of comprehension of the ideas (which was certainly hard), but in finding a voice to say something of worth. Of course, the Kripkes, Putnams and Lewises of the world were not infallible but they sure as hell seemed like it. As I continued in my training my philosophical acumen increased. Not only was I getting better at thinking about metaphysics I was actually enjoying the challenging problems at its core.

This is what motivated me to choose the topic of this thesis. I had no particular expertise on the topic before coming into the research; I had no personal connection to the topic and I had no push to take this as my topic. I merely saw a vexing metaphysical problem and wanted to intellectually challenge myself with issues I had not investigated in depth. This topic has certainly challenged me. From misunderstandings, to false starts and confusion I truly thank my advisor and first philosophy professor for her patience and good guidance. Her constructive critiques have been an integral part of forming my account and hopefully crafting a successful thesis. I would also like to thank the rest of the Philosophy department at Bates for their contributions to my intellectual development.

Finally, my acknowledgments would not be complete without thanking my mother, father and friends for providing useful guidance in stressful times.

TABLE OF CONTENTS

INTRODUCTION

What are we to make of seemingly conflicting concepts? Well, there are two possible courses of action: 1) argue that one of the concepts must be empty if the other concept is true or 2) argue that the seeming conflict does not exist. Philosophers who taken the first course of action are called incompatibilist of whatever concepts they are investigating, while philosophers attempting to show that two concepts to do not necessarily conflict are known as compatibilists. The most famous debate about compatibilism is the battle between hard determinist, libertarians, and compatibilists over free will. In fact the word 'compatibilism' is mostly used to the position that the defenders of both determinism and free will. This thesis will address another type of compatibilism. The debate at the center of this thesis does not center directly on any notions of human agency but it does deal with determinism. The compatibilism at the heart of my thesis is the compatibilism between determinism and chance.

Chances seem to creep into our lives at every junction. This is a chance your favorite football team with get the ball to start the game, your health insurance rate is in part a function of the chance of you getting ill, in Main there is often a chance of snow, and you might be given a certain chance of surviving cancer. We know that chances are related to probability and we even have the mathematical tools to calculate the chance of an event occurring but rarely do we think seriously about what chance really *is*. Like most concepts, the metaphysical depth of chance escapes our daily thought.

This thesis will investigate what it means to be a chance and whether we could have chances in a deterministic world. My project will be a compatibilistic project that builds on existing metaphysical foundations. My intention is not to settle all of the issues that I use to build my account. It is impossible within the confines of this thesis to fully address the nuances of all

of the issues involved. What I do hope to do is provide a strong enough account of determinism and chance that can weather many different views on the smaller metaphysical foundations used to build the argument.

The thesis is constructed on chapters that build on each other. The function of the first chapter is to work through the development of determinism to arrive at the working definition that is used in the remaining chapters of the thesis. The first chapter also functions to show the necessity of taking determinism seriously. In the second chapter I introduce the problem of deterministic chances in all of its glory. Chapters three and four are the chapters that lay the foundation for my positive account in chapter five. Chapter 3 introduces Antony Eagle's Can-Ability Principle (CAP)- a principle that I endorse because of its ability to show what would have to be true of an account of chance for it to posit deterministic chances. As I note in chapter three, CAP does not provide a full account of chance and so I turn, in chapter four, to evaluating Mellor's dispositional theory of chance. Finding Mellor's account promising yet flawed and incomplete, I seek to provide my own dispositional account of chance in the fifth and final chapter.

CHAPTER I

CLIMBING UP THE TOWER

> *Determinism is the perennial topic of philosophical discussion. Very little acquaintance with philosophical literature is needed to reveal the Tower of Babel character of the discussion: some take the message of determinism to [be] clear and straightforward while others find it vague and hopeless…. Here we have, the cynic will say, a philosophical topic par excellence!*[1]

INTRODUCTION

The history of philosophy is lined with debates that critically hinge on a notion of what determinism is or the truth of determinism. The most famous of these debates, of course, being on the compatibilism of free will and determinism. A less famous metaphysical debate involves the compatibility of determinism and chance. Though answers to both of these debates depend quite heavily on a conceptual definition of determinism, philosophers involved in these debates seem to rely on rather vague notions of the central concept. This phenomenon could be due to the an apparent simplicity of the concept or because the concept itself is inherently vague. John Earman points out this problem in the introduction to *A Primer on Determinism*. Earman's *Primer* is supposed to provide some conceptual clarity on both what determinism is and what it means to call something deterministic. Since my thesis is intimately linked to determinism I will follow Earman's lead in explicating a working definition of determinism that I will use for the remainder of this thesis. In this chapter I will work through the historical development of determinism to arrive at John Earman's formulation of Laplacean determinism. Using these insights, I will spell out what it would mean for the world to be deterministic. Specifically, I will

[1] Earman (1986) p.1

briefly investigate the determinism or indeterminism of certain physical theories including classical mechanism and quantum mechanics.

I. DEFINING DETERMINISM

When we think about determinism we normally think of it in relation to events. If we think we live in a deterministic world, we think that, any event X is determined. Usually when we say something is determined we use it to mean that the outcome was already set and could not have occurred in any other way. Our intuitions on determinism can be teased out through a simple example using bouncing balls. If I drop a large amount of bouncing balls into a container, and our world is deterministic, then the balls actions will unfold in one and only one way. We also think that if we know all the laws and conditions affecting the balls' behavior then we, in principle, should have epistemic access to every outcome of every bounce.

a. Fatalism

It is this intuition that scares the fans of human agency. It is thought that if determinism is true then our seeming human agency has no power to change and control the future. This intuition also becomes linked in our human mind with fatalism and destiny. One of the strongest pre-Enlightenment connections between determinism and fatalism is seen in Greek civilization. In Greek mythology the Fates were goddesses who decided the course of an individual's life. Individuals were to merely follow their life's path and be subjected to the will of the Gods. Greek mythology is full of premonitions and oracles telling Greek heroes of their fate. The great Achilles knows he will die young but he also knows there is nothing that he can do to change this

predetermined fact. The link between fatalism and determinism is also seen in Wesley Salmon's retelling of a famous legend.

> … the Stoic philosopher Epictetus, who was a slave, broke a vase that his master, who was a philosopher, treasured. When the master began to beat him, Epictetus protested, "By the philosophy to which we both adhere, it was predestined from the beginning of the world that I should break the vase; I am not to blame and I should not be beaten." His master replied, "By that same philosophy, it was determined for all time that I should beat you," and he continued to do so."[2]

This link to fatalism followed through to early Christian theology. The idea of the Fates was supplanted by an equally powerful Christian God. In both cases a powerful entity had control and infinite knowledge into a person's determined future.[3]

b. Causation

Post-Enlightenment developments in science and philosophy brought us more sophisticated accounts of determinism. Causation became another more sophisticated concept tangled with determinism. This entanglement is derived from William James' 1884 lecture at Harvard's Divinity School. James declared that determinism is true when the fixed parts of the world "appoint and decree" what the future parts will be. James continues to claim that, if determinism is true "the part we call the present is compatible with only one totality. Any future complement than the one fixed from eternity is impossible. The whole is in each and every part,

[2] Salmon (1998) p.2.
[3] Salmon (1998) p.3-4.

and welds it with the rest into an absolute unity, an iron block…"[4] Causation creeps into the Jamesian notion of determinism. On a basic level Jamesian determinism seems to imply that every event has a cause, since the future state of the world must be "appointed and decreed" by the present state of the world, to be the way that it is.[5] This conception of determinism links events in a determined chain of causality. The world can be thought of as a chain of dominos once one falls they all continue to fall in a set pattern thereafter. Another important aspect of Jamesian determinism is the idea of unity. This idea of unity holds that, "a difference at any time requires a difference at every time."[6] From the Jamesian picture of determinism we seem to get the view of a deterministic universe as a unified mechanistic chain of causal events.

This vision, though seemingly intuitive, runs into several major problems. The first major problem is that the existence of causal chain does not guarantee against hidden possibilities. Just because every event has a cause it does not imply that the outcome of the antecedent event will always lead to one unique result. We can image the future world being caused by a present world but this does not mean that it was the only way it could have been caused by the present world. There could have been numerous indeterministic possibilities for that world to turn out. Another way to think about this problem is that if we were to run multiple trials of this world unfolding we could have numerous different future worlds from the same present world. Causation is not a strong enough concept to ground a future based determinism. Another problem is that causation is a famously controversial and vague concept.[7] Notions of causality and events are so vague in fact that they are not even used in physical theories and scientific practice. So to use these terms to explain another equally vague concept is an utterly hopeless endeavor.

[4] Earman (1986) p. 5
[5] Ibid. p. 6
[6] Ibid.
[7] Ibid.

c. Predictability

Once the dust clears from the old notions of determinism the search continues for a conceptual meaning. The next major notion often used when in discussions of determinism is predictability. Predictability is introduced into conceptual formulations of determinism by Pierre Simon Laplace. Laplace's definition of determinism equates determinism with predictability by introducing his famous demon.

> We ought to regard the present state of the universe as the effect of its antecedent state and as the cause of the state that is to follow. An intelligence knowing all the forces acting in nature at a given instant, as well as the momentary positions of all things in the universe, would be able to comprehend in one single formula the motions of the largest bodies as well as the lightest atoms in the world, provided that its intellect were sufficiently powerful to subject all data to analysis; to it nothing would be uncertain, the future as well as the past would be present to its eyes.[8]

This definition forms the basis of theoretical determinism with ramifications for math, physics and philosophy. Laplacean determinism has a very strong intuitive backing behind it, so intuitive that it seems to form the foundations for our quest for scientific knowledge. Essentially, Laplace states that if a system is deterministic then it must work in accordance with strict laws and absolute regularity. We can conceive of a deterministic system like the inside of a watch. On Laplace's account if an all knowing intelligent being can observe the clock at time t1 and is able to tell the totality of the gear's movements, then the system is deterministic. Mark Stone teases

[8] Earman (1986) p.7

out three requirements of Lapalcean determinism. These three requirements relate to: (1) algorithms, (2) unique evolution and (3) error.[9] If we conceive of a deterministic system that is predicable then there must be an algorithm relating the information from the present state to the result of the prediction. As Stone states, " …prediction is what enables us to determine an unknown state from a known state, and we do this by applying the known state as an input to a predictive algorithm."[10] The next requirement of Laplacean determinism is what has come to be called unique evolution. Unique evolution is the idea that one unique state always leads to one unique outcome. If the conditions are kept constant then a state should always produce the same outcome. We can conceptualize this by thinking of, as Robert Bishop does, a movie.[11] If you watch a film in totality then restart the film, a film following unique evolution will play back every scene in the same exact way assuming all conditions remind the same. A film set up that would spontaneously spit out sequences of film would not follow the rule of unique evolution and would not be deterministic. [12] The final constraint is that a deterministic system can be described with a relatively small non-zero error. The prediction must be precise enough to be considered errorless. [13]

Laplacean determinism has come under attack for its strong link between determinism and predictability. There are two major strands of attacks on the predictability and determinism link. One is full out conceptual assault that seeks to separate the two concepts, while the other is critique of the overall notion of the demon/predictor. The first critique is represented by Mark Stone's argumentation in *Chaos, Prediction and Laplacean Determinism*. Stone, after laying

[9] Stone (1989) p.125.
[10] Ibid. p.126
[11] Bishop (2005) p.3.
[12] Ibid.
[13] It will be error less for the demon since our measurements as humans contain some error there will always be some small error involved in our prediction.

down the three criteria for Laplacean determinism, seeks to wedge a divide between the two concepts. He first attacks the idea that algorithms are predictive. Stones ask us to imagine an algorithm to predict the *N*th decimal place in π. The problem for this prediction is that the algorithm would have to be an open-formed solution, which means, that all digits up to the predicted digit would have to be examined to get the answer. Stone contends that after this process we have arrived at a solution where we have not predicted the value at the *N*th place but rather "inspected π." The algorithm we have used has not led itself to a prediction.[14] Stone also argues that deterministic chaos creates a problem for Laplacean determinism. In Stone's deterministically chaotic system changes in state are still regulated by an algorithm and this algorithm is closed. Stone contends that we will be able to make an "approximation" for the output of the system but it would be fraught with error. This leads to an additional requirement for Laplacean determinism. Laplacean deterministic systems must deliver accuracy in the output. According to scientific theories on chaos even if scientist could discover the controlling open-form algorithm for the system, the system would work faster than the prediction; thus, for Stone, making the prediction not a prediction at all.[15] Another feature of chaotic systems is that they are error amplifying. Since we always have error, deterministically chaotic systems will always amplify error thus rendering the demand for accuracy null.[16] The lesson from the trip into deterministically chaotic systems is that there are conceivable systems that are deterministic yet that do not lead to the absolute predictability that Laplacean determinism demands. The bond has been severed.

Earman launches a criticism from another direction. Earman's project is to search for an ontological understanding of determinism. In this sense, the idea of a predictor introduces an

[14] Stone (1989) 125-126
[15] Ibid. 126
[16] Ibid. 127

unacceptable epistemological element into what should be an ontological discussion. He argues that the determinism that you will get from pure Laplacean understandings of determinism depends on the powers of prediction that the demon has. If the demon is all knowing then we get a strong determinism yet if the demon is like us and falls far from omnipotence then we have a much weaker determinism. This leaves us in a situation where we get no real sense of what determinism or a deterministic world actually *is*. There is a need to rid Laplace's and future definitions of determinism of the demon that lurks within. Earman moves forward to try to create determinism without predictability as an essential component.

II. EARMAN'S DETERMINISM

Though Bertrand Russell makes progress in riding determinism of Laplace's demon by using a functional account of what it means for a system to be deterministic, Earman provides an account of determinism using a possible worlds schematic.[17] Earman's reformulation requires there to exist some set of worlds with a particular structure. A world for the purposes of the reformulation is a "4 dimensional space-time world." One of these is the actual world; the actual world is a world that is the collection of all events that occurred, are occurring and that will occur, where events are characterized as changes in spatio-temporal magnitudes. The rest of the

[17] Bertrand Russell provides the final definition of determinism that influences Earman's reformulation. Russell notion of determinism is important for Earman because it purges the epistemological demon from Laplacean determinism. In Russell's determinism the state of a system can be represented by a function

$$E_t = f(e_1,t_1,e_2,t_2,\ldots,e_n,t_n).$$

where "e" are data from the system, "t" are times and E_t represents the state of a system at a time. A deterministic system is characterized by this functional relation and if t is a time within the function then the system is deterministic.[17] The problem for Rusell's notion is that it it is trivially true. Russell himself sees this problem when he states, "…the whole state of the material universe at time t must be capable of being exhibited as a function of t. Hence our universe will be deterministic…but if this is true no information is conveyed about the universe."In fact Earman could adopt a Russell function to describe determinism but he instead chooses to use possible worlds terminology.

worlds are merely possible worlds. A merely possible world on this account is a world with alternative histories to the actual world. With these components in hand we are ready to investigate Earman's definition.

> Letting $\boldsymbol{W}$ stand for the collection of all physically possible worlds, that is, possible worlds which satisfy the natural laws obtaining in the actual world, we can define the Laplacian variety of determinism as follows. The world W $\in \boldsymbol{W}$ is *Laplacian deterministic* just in case for any W' $\in \boldsymbol{W}$, if W and W' agree at any time, then they agree for all times. ….This concept determinism can be broken down into two sub concepts. A world W $\in \boldsymbol{W}$ is futuristically (respectively, historically) Laplacian deterministic just in case for any W'$\in \boldsymbol{W}$, if W and W' agree at any time, then they agree for all the latter (respectively, earlier) times.[18]

Earman's determinism is essentially a supervenience statement. A system is deterministic if a certain state of the system fixes the past and future states of the system. In other words the future and past states supervene on the present state. Supervenience determinism severely limits the modal possibilities in a way that causation does not. When two things supervene on each other they are necessarily linked. So if the future state of the world W' supervened on the present state of the world W it must always do so. If I were to do other trials of the world's unfolding these two specific states of the world must unfold together. Here we see the continued importance of unique evolution to both Laplacean and Earman's determinism. If the world W and its identical copy W' are isomorphic in respect to their properties and have the same laws then they will have

[18] Earman (1986) p.13

the same unique evolution.[19] Earman's definition is meant to be the continuation of a purely ontological Laplacean definition of determinism with none of Laplace's epistemology.

Implicit in Earman's formulation of determinism is a distinction between transitions and properties. This distinction is made clear by Earman's declaration that determinism is not be all or nothing. What he means by this is that some of the world's magnitudes can be indeterminate, thus meaning that a world can be partially deterministic with respect to those magnitudes. [20] The properties of worlds can be indeterminate but the transitions between states of worlds must be deterministic if these states of the world supervene on one and other.

Earman's definition can allow us to make metaphysical statements about determinism that the original Laplacean version cannot do without appeal to an epistemological force. While Earman's determinism forms the basis of how I conceptually use determinism in the subsequent chapters I will not focus on all of his account. Specifically my use of determinism will be limited to Earman's determinism futuristic Laplacean determinism and more specifically its upshot, unique evolution. In Earman's determinism there seems to be the assumption that the laws of nature and time work symmetrically. If one thing is fixed in the present it fixes the past and the future. In looking at the compatibility of chance and determinism we seem focused on the future with the, perhaps wrong, assumption the past is fixed. We are looking to see if there is a *real* chance that an object will Φ in a future time. The forward nature of chances makes it especially important to look at determinism in a manner more akin to the futuristic Lacplacean model with special emphasis on the constraint of unique evolution.

[19] Bishop (2005) p. 3
[20] Earman (1986) p. 14

III. DETERMINISM IN OUR PHYSICAL WORLD

With a strong Laplacean ontological determinism intact we can now figure out whether our world is in fact deterministic. But how exactly can we do this? Assessing whether the world is deterministic will depend on our best physical theories. This, of course, assumes some sort of scientific realism about those theories. In the following section I will assess two of the paradigm physical theories. One of these theories is thought to be thoroughly deterministic while the other is thought to be thoroughly indeterministic. Though I will not delve too deeply in these theories, it is important to see that our world could be either partially or fully deterministic no matter if our world works closer to Newtonian classical mechanics or to quantum uncertainty.

a. Newtonian Mechanics

A world that works under the laws of classical mechanics is usually taken to be a paradigm case of determinism. A pendulum is a perfect example of case where the laws of Newtonian mechanics satisfy the unique evolution component of Laplacean determinism. Newton's gravity also seems to display the characteristics of a deterministic system. This is displayed from a mathematical standpoint. To understand how Newtonian gravitation could satisfy ontological determinism we must simplify the world into point particles with constant positive masses. Newton's second law states that the net force acting on a particle is equal to the product of the mass of the particle and its acceleration. This of course needs a further supplement to describe the nature of force. This is where Newton's law of universal gravitation arrives. This law can be famously described by the equation $F = G\frac{m_1 m_2}{r^2}$. This law essentially states that every point particle attracts another point particle with a force directed along a line which is proportional to the

product of their masses and inversely proportional to the square of the distance between the point masses.[21] If we check for the acceleration of the particle at a certain t and then verify that it its acceleration with the mass equals the gravitational force then we should get one *unique* mathematical answer.

From discussions of Newtonian gravitation and pendulums it seems natural to view classical mechanics as necessarily deterministic but there are some serious flaws in this line of thinking. Earman contends that our notion of the determinism of Newtonian mechanics rests on a particular conception of space, time and motion. He argues that Laplacean determinism makes it the case that space cannot be both absolute and that "all motion is relative to the relative motion of bodies." Since relative motions imply only relative quantities and not absolute quantities like motion there is a certain space-time to support relative motion. This space-time include three things: (1) planes of absolute simultaneity, (2) a metric to measure the spatial distance between simultaneous events and (3) a time metric. Absolute space in this space-time ultimately leads to different future positions for particles in space thus making the system indeterministic because it cannot hold relative motions.[22]

Bishop states the problem for determinism and Newtonian mechanics in the following way. "The root problem…can be traced back to the fact that one's mathematical theorems only guarantee existence and uniqueness locally in time." So he concludes that "determinism might hold locally, but this does not guarantee determinism must hold globally."[23] Newtonian mechanics must not be completely deterministic. From these discussions it is obvious that classical mechanics is not as deterministic as it seems, furthermore it seems that of notions of

[21] Earman and Butterfield (2007) p. 234-235

[22] Earman (2004) p.2-3
[23] Bishop (2005) p.4-5

space, time and motion may make Newtonian mechanics, the paradigm of determinism, not be deterministic at all.

b. Quantum Mechanics

Now that we can see that classical mechanics is not as deterministic as it is thought to be we must look at quantum mechanics under the light of determinism. Quantum mechanics, contrary to classical mechanics is thought of as a paradigm case of indeterminism. This perspective is seen in Einstein's famous quote, "God doesn't play dice." This quote originated as a curt response to Max Born and Schrodinger and Heisenberg's new field of quantum theory. Quantum theory is often thought of as indeterministic with regards to the particles that make up a wave. Particles that make up waves are thought to be indeterministic in terms of measuring individual particles evolution. Not only are these particles able to be measured in practices they cannot be measured in principle. But there are theories like the Pilot-Wave theory which state that a wave evolves deterministically over time thus determining the motion of the particles of the wave, so that the particles follow a unique evolution. This theory is compatible with quantum systems and determinism.[24] What the Pilot-Wave theory does is allow for a phenomenon that is thought of as indeterministic and in the realm of quantum theory and proving a plausible way in which it could still be deterministic and follow the laws of quantum mechanics. Again we see that quantum mechanics may not be as indeterministic as it seems.

The lesson to take from our insight into classical and quantum mechanics is that the best theories of the physical world are indeterminate as whether they are deterministic. Classical mechanics is supposed to be the shining example of a deterministic theory yet, as Earman shows,

[24] Bishop (2005) p.5-6

this need not necessarily be the case. On the other hand the credentials of quantum mechanics, the paradigm of indeterminism, are called into question by theories like Pilot Wave theory which show a way in which determinism and quantum mechanics are compatible.

The point of this discussion was not to provide a definitive answer to the compatibility of determinism and these physical theories. These topics are extremely complex and could warrant a complete thesis in their own right. What I hoped to do was show that the mechanisms (for which ever physical theory) of our world are a lot more complex then they seem at first. Our world despite which ever theory may be true may show elements of determinism and indeterminism.

CONCLUSION

In this chapter we have climbed up the Tower of Babel to arrive at a working definition of determinism. I have settled on Earman's reformulation of Laplacean determinism, not because it is without errors, but because it is the best available option. Earman's definition removes epistemological notions and confused and controversial elements of causation. This leaves an ontological determinism that is robust enough to investigate ontological questions about chance. It should be noted that from here on that the notion of determinism used in this thesis will refer to Earman's reformulation with special emphasis on unique evolution. From determinism I dived into the world of physics. In trying to figure out the true indeterministic/deterministic character of our universe I showed that our best theories provide little conclusive results. This sets the stage for the question that will be the focus of the rest of the thesis. From the inconclusiveness of the scientific theories we can conclude that our world could very well be deterministic, or partially deterministic. We can also definitely say that deterministic universes are a possibility and that other possible universes might be deterministic even if this one is not. Knowing that

determinism is a valid possibility we can now turn our sights on investigating the metaphysical ramifications of deterministic systems on objective chance.

CHAPTER II
AN UNHOLY UNION?

Thus there cannot be deterministic chance. All there can be is deterministic ignorance.
(Schaffer 2007)

INTRODUCTION

Our best physical theories of the universe have proved inconclusive on the veracity of determinism. No matter which physical theory happens to be true, be it closer to classical mechanics or quantum theory, there appears to be at least a possibility of determinism. Moreover, even if our world is not deterministic it seems that determinism could be true in some other possible world. It is with these possibilities that we must consider the metaphysical ramifications of determinism. The specific ramification that I will be investigating is the ramifications of determinism on chance. Are determinism and chance compatible? What would it be to have a concept of chance that was compatible with determinism? In the current chapter I will address these questions. I will investigate the contours of chance, what a deterministic chance could be and arguments for their incompatibility. Although this chapter will end on a pessimistic note by echoing Jonathan Schaffer in claiming that the major compabilitist theories of deterministic chance fail in the following chapter I will pursue a more positive account of deterministic chance.

I. THE PROBLEM

It is the start of a football game and both teams come to the 50 yard line. At the 50 yard line a referee presents a fair sided coin with a side marked heads and a side marked tails. The referee asks one team to choose one side while the coin is flipping in the air. If the coin lands on the side that the team selected then that team gets the privilege of choosing how to start the game. This is an example of a coin flip. The intuition behind the coin flip is that a fair coin has 2 sides and that both of these sides are equally weighted, and that therefore there is a 50% chance that

either side is landed on. The simplicity of this case has made the coin flip a paradigm case of chance. But there is a deeper intuition that grounds the coin flip. When we flip the coin we believe that there is an almost undeterrmined future for the coin, meaning that there is an actual ability for the coin to flip either heads or flip tails. After the coin flip we think that it actually flipped that it could have flipped otherwise. This chance is what is referred to as objective chance.

Objective chances are not restricted to coin flips- they also seem to play a vital play in science. One of the most prominent examples of objective chances in the deterministic chance literature is radioactive decay. Radioactive decay is seemingly based on objective chances and objective probability. Particular samples of radioisotopes are unstable and unpredictable. Scientists try to get a sense of the half-life of the isotope by assuming that these events are completely random. From this scientists observe patterns of decay by taking into account the chances and randomness of the behavior of the nucleus. In this case objective chance has an explanatory role in science. There are other examples of probabilistic laws in science but those will be looked at in greater detail in the following sections.

That seems simple. It seems to be an open and shut case- our world consists of objective genuine chances. This is the strong intuition that we act on and live our lives by but this like so many of our intuitions calls for stronger investigation. Let us turn back to our work on determinism. We roughly arrived at the concept of determinism as something like this the world in its current state supervenes on the world at a past time. This introduces us to the idea of unique evolution. If a system is to have a certain set of initial conditions then it will result in a unique outcome. So what does this mean for chance? It seems as though the progression of the world and its laws must already dictate an outcome of a "chancy" event(an event with an objective

chance between 0 and 1) if determinism is true, thus meaning that determinism and chance are incompatible. This is similar to the seeming incompatibilism of determinism and libertarian notions of free will. If determinism is true it seems the coin that we are flipping could not have flipped any other way than what it actually flipped. If the coin is placed into intial conditions of the same sort than it should always produce the same one outcome.

But this defines everything we have learned about probability. We know that the chance of a coin flipping heads or tails is 0.5 but if determinism is true than it must be 1 (it will occur) or 0 (it will not occur). In a deterministic world it seems like there cannot be chances between 1 and 0. What are we to make of this conundrum? There are two ways in which this problem can be solved. The first way is to declare the two concepts incompatible and to either argue there are no objective chances or argue determinism is false. The other option is to take the compatibilist track and argue for a deterministic conception of chance. The choice taken by incompatibilist is to claim that there are no objective chances and claim that the chances that we think come up between 0 and 1 are actually epistemic chances. Epistemic chances are merely our guesses of the likelihood of a future event. We do not know all of the deterministic laws of nature therefore we guess the outcome of the coin flip even though it is metaphysically decided. Epistemic chances comes from our ignorance. There is no open undetermined future and thus no genuine way the object could do otherwise. The epistemic or subjective chances have come under fire from a cadre of compabilist philosophers trying to craft room for an objective notion of chance. Before we dive into the compabilist accounts of chance we must have a deeper metaphysical understanding of the role we need an objective chance to fill.

II. THE ROLE OF CHANCE

The incompatibilist position is strong and may characterize most philosophers' feelings on the issue but it has not squashed the incompatibilist's project. A few philosophers have tried to provide an account of deterministic chance. In order to understand how a determinsitc chance works we need a deeper metaphysical understanding of chance. In order to analyze chance I will be borrowing a critical distinction Jonathan Schaffer develops in his aptly titled essay *Deterministic Chance*. Schaffer makes the distinction between chance-formal and chance-substantive.

A. CHANCE-FORMAL

A concept of objective chance is linked with an account of objective probability. Schaffer explicates a formalistic definition of chance which takes on a probabilistic character. He calls this account chance-formal because it is a based line definition with little metaphysical import. Chance formal includes three major parts: 'p,''t' and 'w' where 'p' represents the proposition that the event occurs'w' represents a world and't' represents the time in which the event is occurring. Put together with chance we get 'ch<p,w,t>' which reads the chance of p holding at world w and at time t. The chance function also must have a component that explains that represents and that in our world there are chances between 0 to 1 that proposition p will hold. This leaves us with our formalistic account of chance:

Chance is probability function: $ch<p,w,t,>\rightarrow[0,1]$.[25]

The interval in the function is to be read as between 0 and 1. So put in terms of a coin flip: $ch<p_{head}, w, t>\rightarrow [0.5]$. This provides a formal representation of our basic understandings and intuitions of what a chance is. The problem with chance-formal is that by itself it does not

[25] Schaffer (2007) p.115.

distinguish between epistemic and objective chances. A chance from that function could be between 0 and 1 yet be epistemic. What is necessary is more metaphysical meat on the strong formal skeleton.

B. CHANCE-SUBSTANTIVE

Schaffer provides a list of six generally accepted metaphysical notions to which chance is connected. The six notions are: the principle principal, the basic chance principle, the realization principle, the future principle, the intrinsicness requirement, the lawful magnitude principle and the causal transition constraint. The combination of these notions creates what Schaffer calls chance substantive. Chance substantive can give us a greater understanding of the metaphysical relationship between theories of objective chance and determinism.[26]

The first and most discussed of these requirements is David Lewis' Principal Principle. Lewis' Principal Principle (PP) was first introduced in his *A Subjectivist's Guide to Objective Chance* (SGOC) in 1986. The Principal Principle basically connects our epistemic belief in a chance occurring to the metaphysical chance occurring. Lewis begins SGOC begins by parsing notions of probability from chance. As a subjectivist about probability Lewis sees probability as nothing more an epistemological framework but he is trying to craft a space for objective chances. Subjective probability involves both credence and objective chances for Lewis. Credence is a rational belief in the outcome of an event. Lewis classes credence and chance as filling two different concepts of probability. He seeks to investigate the "second-order" relationship between these two concepts of probability, and more specifically credence about

[26] Ibid. p. 123.

chance. Credence about chance involves the rational belief in the chance of an event occurring. The relationship between the notions is what creates the Principal Principle.

Lewis believes that the Principal Principle encompasses all that we need to know about chance. He develops the principle through a four part questionnaire. The questionnaire is supposed to show the linkage of rational belief in the proposition about an event and the chance of the event happening. If a fair coin if flipped then there is a 50% chance that the coin will land heads but it also must be true that our belief in the coin flipping heads must also be 50% due to your knowledge that the coin is fair. The questionnaire also shows the importance of evidence in forming a rational belief.[27] This leads to the Principal Principle. The Principal Principle has five major components: the credence function, a real number x, the proposition X and admissible evidence E. The credence function is "a probability distribution over (at least) the space whose points are possible worlds and whose regions (sets of worlds) are propositions."[28] The next portion is x where x is a real number. This real number is the chance of an event occuring at a certain time. The Proposition X is the "proposition that the chance, at time t, of A's holding equals x."[29] What is admissible is represented by E. Lewis allows two pieces of information to be admissible: 1) historical information up to the time of the event and 2) hypothetical information about the chance itself are admissible. What is not admissible is the actual occurrence of the event. With these parts in hand the Principal Principle can be stated:

Principal Principle: $C(A/XE)=x$[30]

The credence in A holding with the admissible evidence will equal the chance of the event occurring. Though Lewis may have thought this was this was exhaustive of chance, there seems like there are many more metaphysical components of chance.

[27] Lewis (1986) p.265.
[28] Ibid. p.266.
[29] Ibid. p.269.
[30] Schaffer (2007) p. 23

The next principle Schaffer borrows from Bigelow et. al. The borrowed principle is the Basic Chance Principle. The Basic Chance Principle, as stated by Bigelow et. al, is the idea that if we "suppose x>0 and $Ch_{tw}(A)=x$. Then A is true in at least one of those worlds w' that matches w up to time t and for which $Ch_t(A)=x$." The Basic Chance Principle states that if there is a non-zero chance that an event occurs at t in w then there is some possible grounding world where the event occurs which also matches the world w's history up to time t. Since the possible world grounds the present world and they are the same until t, the chances on both worlds are the same. Written in a Schaffer's framework the Basic Chance Principle reads as this:

> *Basic Chance Principle*: If ch<p,w,t>>0, then there exists a world w_{ground} such that: (i) p is true at w_{ground}, (ii) w_{ground} matches w in occurent history up to t, (iii) ch<p, w_{ground}, t> = ch<p,w,t>.[31]

The Realization Principle is very similar to the Basic Chance Principle. The only difference is that the Realization principle adds the requirement that the grounding world and the actual world match with respect to laws. The justification for this principle is straightforward. The laws of the universe fix the chance of an event occurring in the actual world so the same laws must be in place to ground the chance in the possible world.

The fourth principle involves the future. David Lewis explains how chances in the world are time-dependent.[32] Lewis uses the example of reaching the end of a maze to explain the time-dependent nature of chance but I will use a rather morbid example to draw out this intuition. Joe was in a terrible accident and has been flown to the emergency room. If doctors cannot save life in an hour he will die. At the time of arrival, 11:00 PM there is a 50% chance that the doctors will be able to save Joe by 12:00 AM. Its 11:30 PM and still no success by the doctors; Joe's chance of survival has decreased to 25%. At 11:50 PM when Joe's chances are at a mere 10%

[31] Ibid. 24
[32] Lewis (1986) p. 271

the doctors fortuitously manage to perform the necessary operation for Joe's survival. At 11:55 the operation is done and Joe's chance of survival is 100%. This example and Lewis' labyrinth example are supposed to show that chance not only has a time dependent element but also that chance concerns elements in the future. Chance exploits the asymmetrical nature of time. This aspect of chance informs the future principle:

Future Principle: If $0 < ch<p_e,w,t> < 1$, then $t < t_e$[33]

The principle reads that if the chance of an event occurring is between 0 and 1 then the time of the event must be in the future.

The Intrinsicness Requirement is relatively simple. If an intrinsically duplicate is put through the same test under the same conditions then the chance of the duplicate Φ-ing will be the same in all duplicate trials.[34] If I had three coins and two of these coins were intrinsic duplicates and the coins were flipped in intrinsically duplicate trials then the chance of the coins flipping heads should all be the same value.[35]

The Lawful Magnitude Principle is supposed to connect chances to laws. Schaffer states that the Lawful Magnitude Principle is:

> If $P_{tw}(A)=x$, then there is a lawfully entailed history-to-chance conditional of the form: if the history through t is H, then $ch_{tw}(A)=x$.[36]

The LMP is supposed to show the close relationship between the laws of nature, through history-to-chance conditionals, and the specific chance values. Where the BCP and the RP relate chance to worlds the LMP shows how chances work in relationship to laws.

[33] Schaffer (2007) p.125.
[34] Intrinsic duplicates are the same in every property of the object that makes up an essential part of what it means to be that object.
[35] Schaffer (2007) p.125-126
[36] Ibid. p. 126.

The last requirement of chance-substantive deals with causation. Arguments for objective chance often leave a place for chances to explain various causes and effects. Adherents to objective chances used radioactive decay and events like ice melting to appeal to this argument. But in order for this to be true the chance must be within the transition. Outside of the transition the chance has no impact. Schaffer calls this the Chance Transition Constraint.

> *Casual Transition Constraint*: If $ch<p_{e,}\ w,\ t>$ plays a role in the causal relation between c and d, then $t_e \in [tc,\ td]$.[37]

With these principles complete Schaffer's chance-substantive. In conjunction with chance-formal we have a complete definition of what an objective chance must be.

> *Chance*: Chance is the probability function from propositions, worlds, and times onto the closed unit interval, which best satisfies: (i) the Principal Principle, (ii) the Realization Principle, (iii) the Futurity Principle, (iv) the Intrinsicness Requirement (v) the Lawful Magnitude Principle and the Causal Transition Constrain. [38]

A complete conceptual understanding offers much more than mere clarity. The new understanding of chance with these formal and substantive elements allows the theories of chance to be adjudicated.

C. TYPES OF CHANCE

Beyond a conceptual understanding of chance Schaffer also explains the various types of deterministic chances that have been argued for. In the philosophical literature there is a tradition

[37] Ibid.
[38] Schaffer (2007) p. 126.

of dividing phenomenon into macro and micro events and objects. Micro-events and objects are things on the microscopic molecular level. They are objects like atoms, and quarks and events like molecular bounding and fusion. Macro-events, on the other hand, are large perceivable objects and events that involve a large complex collection of micro-objects and events. Chances also fall parasitically onto this divide. Micro-chances are chances that involve micro-events and objects. The chance of an electron doing something would be a micro-chance. Macro-chances are chances involving macro-events and objects. Coin flips are macro-chances.

Chances are also divided by the time of their occurrence. The divide here is between initial and posterior chances. Initial chances are chances that happen at the beginning of everything. A chance at the Big Bang would be an initial chance. Posterior chances are chances that occur after this the initial start of the universe. Coin flips, radioactive decay, reaching the end of a maze all fall under the title of posterior chances.

From these distinctions we get four distinct types of chances. There are micro-initial chances, micro-posterior chances, macro-initial chances and macro-posterior chances. Micro-initial chances are chances that occur on the micro-level at the beginning of the universe. The chance of a particle performing a certain action at the Big Bang would satisfy a micro-initial chance. A macro-initial chance would also be at the beginning of the universal but occur at a higher level. Micro-posterior chances involve chances that occur after the begging of time and are on the micro-level and macro-posterior chances are chances that also occur after the beginning of time but on a macro level.[39] Theories of chance will be compatible with some or all of these chances. The role of chance and the types of chance give us a clearer means for evaluating the theories of objective chance and provide a meeting point to assess compatibilism.

[39] Schaffer (2007) p. 120-121.

III. ARGUMENTS FOR AND THEORIES OF OBJECTIVE CHANCE

There are at least four arguments for the existence of deterministic chances.[40] In this section I will divide these four into two based on their strength in the literature on deterministic chance. The first camps that I will briefly analyze are the less successful arguments deterministic chances. These arguments include the no connection argument, paradigm chance argument, and the non-reduction argument. The second camp that I will analyze provides more than just a mere argument for compatibilism they provide a theory of what chances are. This group roughly is made up of proponents that view chances as something close to propensities these theories also all take from the pulpit of David Hume and Best Systems Analysis of the Laws of Nature. The theories I will address in this camp in are those by David Lewis, Barry Loewer and Carl Hoefer. The theories from this camp pose the greatest threat for incompabilist so I will thoroughly analyze this camp (which includes battling a *big bad bug*).

A. THREE COMPATIBILIST ARGUMENTS

The no connection argument declares that there is no connection between deterministic laws and chance. Proponents see determinism as being a supervenience statement that links the past to the future outcomes of the world. They see chance merely as chance formal and relating to propositions at a closed interval of time. When the concepts are looked at in this manner there does not seem to be much of a connection. The paradigm case argument holds (1) that coin flips are paradigm cases of objective chance and (2) coin flips are deterministic systems. For these philosophers this entails that there are objective chances in our deterministic world even if we cannot explain their existence. The next argument is nonreductionist. This argument holds that

[40] Schaffer (2007) p.114-120.

even though there may be determinism at the micro-level this does not work up to the macro-level. The macro-level would have to have an independent reality from the micro level and it is in this reality where chance roams free. This is a compatibilist account of chance because the world is still deterministic and chance coexists in one world.

Each of these arguments for the existence of objective chances in a deterministic world is compatible with a certain type of chance. The no-connection argument is compatible with all of the types of chances since it finds no problem in having determinism and objective chances. The paradigm case argument is wed to deterministic posterior macro chances of both varieties.[41] Since the paradigm example is a macro event (coin flipping) the paradigm case argument is committed to the existence of these macro-chances. Since the non-reductionist argument is committed to the determinism on the micro-level and indeterminism and the macro-level they explicitly support macro-chances.[42]

Schaffer provides in-depth arguments as to why these argument's types of chances fail but I will provide more basic attacks on these arguments and will attempt to show that they are too troubled to be taken seriously as providing solid arguments for objective chances. The simple problem with the no-connection argument is that it is too restrictive in how it looks at chance. The proponents of this argument see chance only as a probability function stretching across propositions. As we have seen before an objective chance must have a much greater role. The metaphysical implications of objective chances connect chance to determinism. The paradigm case fails because it ignores the fact that a coin-flip does not necessarily represent an objective chance. The chance of a coin flipping a certain way could represent an epistemic chance. The

[41] In order to see how the paradigm example argument supports macro-initial chances it is important to realize that the paradigm argument is not just unique to coin flips. That is just one chance. A compatible macro-initial paradigm would be the Big Bang.
[42] The non-reductionist also may not support deterministic macro-chances.

defender of paradigm chances needs a further argument to show why the chances resulting from coin flips in a deterministic world are true objective chances and not measures of our lack of knowledge. The final non-reduction argument is flawed in the sense that it relies heavily on the notion of a mysterious independent reality. The previous arguments have not seemed to gain much steam in the literature most like because of these flaws and ambiguities. The next batch of theories has a much stronger philosophical framework and poses a serious threat to incompatibilist.

B. THE HOLY TRINITY: HUME, LEWIS AND CSM

The following arguments for the existence of objective chances also offer a theory of objective chances. But beyond all offering a theory of objective chances they all take from Humean metaphysics. David Lewis carries the torch of Hume into $20^{th}/21^{th}$ philosophy with his Best System analysis of the properties of the world and the laws of the world. Lewis' Best System Analysis creates a theory of objective chances. Barry Loewer marries this Lewisian theory of chance to Classical Statistical Mechanics. Finally Carl Hoefer offers an alternative to Lewisian chances but still maintains a Humean framework.

Lewis starts off with an understanding of chance that seems to lead him towards a propensity account of chance but then diverges from the projected pathway. Lewis thinks that chances are given by propositions in the language of physics that say that an event will occur at a particular time and in a particular location. Chance, for Lewis, relies on the future, is an essential part of a causal nexus and adheres to the Principal Principle. To provide a theory of chance Lewis relies heavily on his Humean metaphysical picture of the world. The doctrine of Humean Supervience is an essential part of understanding Lewisian chances. Humean Supervience is the doctrine that the truths of the world supervene on spatio-temporal categorical properties. These truths include

the laws of nature.[43] In the tradition of philosophy of science there has been much discussion of what exactly is a law of nature is. Lewis answers this question there this Humean framework and with a position that he calls the Best Systems Analysis (BSA). Laws, on Lewis' account, are regularities. Consistent with the doctrine of Humean Supervience they are fixed by the categorical properties of the universe. When analyzing the theories of science the fundamental base is represented by L. Suppose that L is a language of fundamental properties, atomic predicates, spatio-temporal predicates and mathematics and logic. Theories represent deductive systems of laws that supervene on truths expressed in the language of L. These laws are the truths of the theory that best balances the properties of strength, fit and simplicity.[44] These deductive systems represent the best systems. This is where chances make their entrance into the Lewisian picture.

Chances and probabilistic statements enter in the Best System Analysis. The probabilistic laws of science are entered into the deductive system. The entrance of these probabilistic laws increases the fitness of the general theory. In this relationship is the definition of chance. Lewis states that "… chances are what the probabilistic laws of the best system say they are."[45] The L-laws entail L-chances and the laws are in turn fixed by the categorical properties within L.

Loewer accepts Lewis Best Systems analysis and tries to expend it to make sense of physical theories that include probabilities. One such theory that combines determinism and probabilities is classical statistical mechanics. The strand of classical mechanics that Loewer explains has three main postulates. The first postulate is that there are fundamental dynamical laws. These laws are deterministic. The second postulate involves probability. It declares that there is "a uniform probability distribution the micro-canonical distribution over the possible phase points

[43] Lewis (1994) p. 473- 474 and Bigelow et al. (1993) p.444
[44] Lewis (1994) p. 478
[45] Ibid. p. 480

at the origin of the universe…" The final postulate is a statement that the origin of the universe was a "special low-entropy condition."[46] CSTM needs objective chances since it places so much causal and explanative significance in probability. An example of the significances of object chances to CSTM involves an explanation of why ice melts:

> The explanation proceeds roughly by citing that the initial macro condition of the cup of water + ice is one in which on the micro-canonical probability distribution it is overwhelmingly likely that in a short amount of time the cup+ice cube will be near equilibrium; i.e. the ice cube melted. If the probability appealed to in the explanation is merely a subjective degrees of belief then how can it account for the melting of the ice cube?... The explanation within CSTM for the lawfulness of these generalizations invokes the microcanonical probability distribution. Now it just seems incredible that what endows these generalizations with their lawful status is a subjective probability distribution. Surely what the laws are is not determined by our degrees of belief.[47]

This need for objective chances creates a paradox for CSTM. If dynamical laws are deterministic and deterministic laws are incompatible with probabilities then it would seem like we must hold that the probabilities involved are subjective. But it seems as though CSTM needs objective chance because subjective probabilities cannot ground laws.[48] Loewer believes that Lewis Best Systems is the best theory of chance to solve this paradox. The paradox of CSTM is solved because CSTM represents the candidate for a best system. The postulates of the system are the dynamical laws and the probability distribution at the initial conditions of the universe and the condition of low entropy. "The contingent generalizations [the CSM system as a best system]

[46] Loewer (2001) p. 2.
[47] Ibid.
[48] Loewer (2001) p. 5-8.

entails are laws and the chance statements it entails give the chances."[49] Since the probabilities that are in a classical statistical system are part of a strong, fit, informative Best System they are laws. This is how the objective probabilities ground laws and since they are distributions at the initial conditions of the universe they escape the conflict with dynamical laws. Here we have the marriage of BSA and CSTM to provide a Humean account of objective chances.

Carl Hoefer provides a differing Humean picture of chance. Hoefer declares that his view is like Lewis' but without the reduction to the microphysical level. Hoefer follows Lewis in two key ways: (1) he adheres to the Principal Principle and (2) he views objective chances as entailed by "patterns of events" in the world rather than being properties or propensities. Hoefer provides a list of five features of his theory of chance. The first principle links chances to structure and logic Chances are probabilities of outcomes from a "proper chance-setup" and derivable from logic and "probabilistic" axioms. Hoefer keeps Humean Supervience at the second feature of his chances. The principal principle represents the third leg of his third way on chances. The fourth feature is that objective chances are grounded by the fact that events, even though on many level they appear random, they have a stable distribution over time. This is supposed to make the theory consistent with the principal principle. The final feature is that some macroscopic chances supervene on the structure of the chance-setup. This is linked to Nancy Cartwright idea of Stochastic Nomological Machines that generate regularities.[50] Not all objective chances come from this machine but if a chance set-up produces enough stability and randomness over history then that stability and randomness constitutes an objective chance.[51]

All three of the above mentioned theorist come from a Humean anti-necessitarian background. All three also agree that chances are entailed by a vast mosaic of patterns. Loewer

[49] Loewer (2001) p. 9.
[50] Hoefer (2007) p. 1.
[51] Ibid. p.16

follows Lewis into the best-systems camp that ground chances in a deductive system of which there are probabilistic laws while Hoefer grounds chances in the long run pateerns of outcomes of chance. Both Lewis/Loewer and Hoefer rely heavily on the idea of chance as a supervient property. It is this reliance on supervience that leaves them open for attack. Objective chances of the Humean variety will have to overcome a big bad bug lurking in the distance.

IV. ATTACKS ON HUMEAN CHANCES

There are two attacks that the Humean project must overcome. The first of these problems is the infamous *big bad bug*. The bug, as we will see, causes problems for the Principal Principle. The second line of attack comes from comes from Jonathan Schaffer's attacks on initial and posterior chances.

A. THE BIG BAD BUG

To understand the bug it is necessary to go back over chance and supervenience. On Lewis' account chances supervene on the total history of the world and a complete theory of chance. This is where the supervenience relationship comes into conflict with the Principal Principle. The Principal Principle states: C(A/XE)=x with the supervenience relationship taken into account we can reformulate this relationship to C(A/HT)=x, so where H represents the intial history and T represents the complete chance theory. With further derivation we get C(A/HT)=P(A). The statement we are left with is that the credence in A is conditional on the initial history and a theory of chance and that that credence should equal the probability of A. The problem come in what philosophers call undermining futures. The problem is that possible non-actual futures in conjunction with the initial history produce the chance theory which relies

on the actual present chances. The Principal Principle The chance-theory cannot accommodate possible futures.[52]

Lewis and Hall try to reformulate the Principal Principle to avoid this problem this becomes known as the New Principle.[53] They formulate the principle in a way that changes the focus of the credence. Rachel Briggs states: "NP states that a rational agent's credence in a proposition, conditional on a complete theory of chance, equals her expectation of its conditional chance, given the same theory."[54] On the other hand, the Principal Principle only stated that an agent's credence is equal to the chance of the event. The new Principle stands as this: $C(A/H_{tw}T_w)=P_{tw}(A/T_w)$. This is referred to as the New Principle. The New Principle gets around this problem by placing the credence in the complete theory of chance rather than the chance of an event.

Though this move seems like a solution Briggs concludes that it relies on an incorrect theory of chance. She argues that there are two ways in which chance can be viewed. View 1 is that chance is what she calls a database-expert. Database-experts get their strength by having more information than others. The analogy she uses is to that of an eyewitness. Eyewitnesses are valuable because they have more information than those who were not at the scene. The credence function of someone being advised by the eyewitness is represented as: $C(A/G(A) = x) = x$, where G represents the expert's advice. On the other hand there is the analyst-expert the analyst expert is like a relationship columnist. Her expertise is not based on having any more specific knowledge of the situation but being able to analyze the situation and offer advice. The credence of someone following this expert's advice is: $C(A/G(A/E)=x)=x$. Where this fits into a critique of the NP is that the database rule represents PP while the analyst rule represents the NP. The NP

[52] See Briggs (2009).
[53] See Lewis (1994) and Hall (1994).
[54] Briggs (2009) p. 437

represents chance as an analyst. Briggs concern is that Hall by assuming chance is like this is moving in an un-Human direction. If Humean supervenience is true chance as a witness knows both the past and knows the future. It is on this knowledge or supervenience on the future that chance give advice, if the future were different there would be different advice. In this sense chance seems more like an eyewitness than an analyzer.[55] Briggs also offers a direct criticism of Hoefer's theory of chance by arguing that it does not avoid the bug. What we seem to have are two theories that have not solved the infestation or have solved it at an unacceptable price.

B. SCHAFFER'S ATTACK

Schaffer attacks the Humeans in a more general attack on the type of chances that they posit. Rather than attack the bug and using a strategy to show an inconsistency between HS and objective chances he argues that their chances are incompatibile with chance-substantive and thus cannot fill the role of what we need an objective chance to be. Humean chances are maco-initial chances. They represent macro-initial chances because they exist from probabilistic laws distributed at initial conditions, according to Loewer. Schaffer contends that initial chances violate: the principal principle, the lawful magnitude principle, the intrinsicness requirement and the causal transition connection.

To show that initial chances violate the principal principle, we can consider similar reasoning as the big bad bug argument. When explaining why initial chances violate the Lawful Magnitude Principle Schaffer directly refers to Loewer. The three postulates of classical statistical mechanics are supposed to ground the existence of macro-chances. These postulates are in turn supposed to represent a best system. Schaffer gives two major flaws in this argument. The first problem is that the fundamental base L can only contain natural categorical properties

[55] Schaffer (2007) p.130

amongst other things of which low entropy is not one of them. The third postulate takes CSM out of the running to be a best system. The second problem is that CSM has shift competition that Loewer does not consider. This fact casts doubt on CSM being the ground of macro-chances.[56] The initial chances run into conflict with the intrinsic requirement. Initial events that happen at the big bang cannot be replicated but if we imagine a recurring eternal oscillating occurrence from the big bang Schaffer contends that this leads us to posterior chances. Finally initial chances fall outside of a causal nexus. In the ice example the chance must come between the event of the ice entering the cup and the ice's melting. In the case of initial chances the chance falls outside of the event and is stuck at the big bang.[57]

CONCLUSION

The overview that I have given has been pessimistic towards the prospect of a deterministic chance. I have followed the scholarship to show that the best opponent of incompatibilism is actually plagued with many problems. From bug infections to conflicts with the role of chance the current crop of theories seem to fail to encapsulate what we need from an objective chance. In the next following I will evaluate a position that links chance to ability and 'can' statements and will work towards a new account of chance.

[56] Schaffer (2007) p.136
[57] Ibid.

CHAPTER III
ABLE BODIES

INTRODUCTION

The prospect of a deterministic account of chance seems bleak. In the last chapter we examined the arguments for a deterministic account of chance and the types of chances that these arguments allow. We have seen that these accounts are not sufficient for an account of deterministic chance. But through our investigation we found several roles that an objective chance must fill. An objective account of chance that is compatible with determinism must adhere to the Realization Principle, the Basic Chance Principle, the Principal Principle, the Future Principle, the Intrinsicness Principle, the Causal Transition Constraint and the Lawful Magnitude Principle. These principles seem to provide a formidable criterion for any theory of deterministic chance. Schaffer concludes that there can be no account of chance that wades through this gauntlet of principles but Antony Eagle is more optimistic. In his 2011 essay, aptly titled *Deterministic Chance,* Eagle examines another critical element of objective chance. He adds a new constraint that he believes can eventually lead to an account of deterministic chance. This new principle is called the Chance-Ability Principle. This chapter will be devoted to an explication of this principle and its role in potentially shattering claims of incompatibility.

I. THE CHANCE ABILITY PRINCIPLE (CAP)

Eagle begins by trying to simply understand what makes certain basic sentences about chance false. He analyses two obviously false sentences. These sentences are:

a. This coin can land heads when tossed; still, it has no chance of landing heads when tossed

And

b. This coin can't land heads when tossed; still it has some chance of landing heads when tossed.[58]

Eagle analyzes the falsity of these sentences. Structurally these two sentences are composed of two conjuncts. Both conjuncts have a truth component. 'This coin can land heads when tossed' can be true or false. Similarly, the latter conjunct 'it has no chance of landing heads when tossed' can also be either true of false. This is important because it grounds the problem with these sentences. What makes them false is the truth of one of the conjuncts excludes the truth of the other. But what grounds the truth of the conjuncts is an important word in the first conjunct. This word is 'CAN.' If the object 'CAN' do the action in question then the conjunct is true. For Eagle this is what grounds chance. "The simplest explanation for this…is that ascriptions of non-zero chance entail, and are entailed by, 'CAN' claims."[59] The 'CAN' claims are to be thought of as dynamic "ascriptions of ability."[60] Following CS Pierce he asserts that chances rather than being merely connected to "bare abilities" are embedded in habitual generalizations derived from a chance setup. By this Eagle means that a proposition like 'The dice can roll six' is linked to a habit for the dice to roll six. This habit is expressed as 'X Φs when C.' This expression leads into a principle that links chance, 'CAN' claims and ability together. This principle is called The Chance-Ability Principle (CAP).

[58] Eagle (2011) p.271
[59] Ibid.
[60] Eagle makes the distinction between 'CAN' claims thought of in a dynamic sense and 'CAN' claims thought of in an epistemic chance. Dynamic can claims have a power attached to them. For example "I can't jump." While epistemic 'CAN' do not have this power association. Example: "You can't be serious!" Eagle contends we are supposed to understand 'CAN' claims in relation to chance a dynamic.

> **The Chance-Ability Principle** (CAP) Where X is a noun phrase, and Φ a complement verb phrase, the chance of X Φ-ing exceeds zero iff X can Φ. (Similarly, as 'MUST' is dual to 'CAN', the chance of X Φ-ing is one iff X must Φ.)[61]

CAP has larger implications for determinism and freedom as well as determinism and chance. Eagle supports a metaphysical position called universalism. Universalism about chance holds that every physically possible event has a chance other than 0 and 1. In a footnote Eagle notes another formulation of universalism. This formulation holds that there is a chance of truth of any physically possible proposition.[62] The notions of physical possibility seem to work with positive non-zero chances. To say something is physically possible is to say that there are no contradictions in with the physical nature of our world that make the possible event impossible. If this is so then it seems as though there is a chance of the event occurring. Where universalism might run into problems is with past events. It is seems possible that there is a counterfactual past occurrence but this possible event does not have a non-zero chance of occurring, in fact it has a 0 chance of occurring because it did not occur. But I think this supposed problem is unstable. In order to have a physically possible counterfactual occurrence time would have to be symmetrical. Were time asymmetrical and the past closed then the possible counterfactual occurrence would

[61] But there is a problem with CAP that Eagle must work through. CAP seems to fail to allow the situations where the chance of an X Φ-ing is possible yet the probability of it happening is zero. So the X CAN Φ yet its chance does not exceed zero. The example of this phenomenon is a point –sized dart hitting a point on a dartboard. CAP seems to violate fundamental probability calculus.

To circumvent this problem Eagle introduces a distinction between can and possibly. In order for the dart example to be a true counterexample to CAP is must posit a strong link between can and possibly. The implicit assumption in the example is that can and possibly are synonymous. Since there is a POSSIBILITY that the dart can hit a point it is thought that it CAN hit a point. This link is severed though if we consider CAN as dynamic. Possibility claims are modal and express elements of metaphysical possibility. Can claims on the other hand are more restricted powers in the actual world. So 'CAN' in the example of dart is used to signify logical and metaphysical possibility. Though it can happen logically it is not the CAN of our CAP principle, in terms of the dynamic can in CAP the dart example cannot happen and thus is rightly afforded a zero probability.

[62] Eagle (2011) p.279-280

not be physically possible it would rather be merely logically possible. The only way that a physically possible counterfactual event could have occurred is with a world where time works symmetrically. But if time were to work symmetrically then it makes perfect sense to say that the counterfactual possible occurrence could have a non 0 or 1 chance of occurring because in that world the past is not closed.

This belief in universalism grounds the way in which Eagle reconciles CAP, determinism and chance. Eagle differentiates between how compatibilists and incompatibilists on determinism and free action view 'CAN' claims. The first view is that of the incompatibilists. The incompatibilists, according to Eagle, view 'X CAN Φ' as something like "It is not now settled that X does not Φ." [63] CAP is consistent with the incompatibilists because in their view the object does not have the ability to Φ based on its present behavior of not Φ-ing. The compatibilists by contrast can read 'X CAN Φ' as "X's intrinsic state and immediate circumstances are consistent with Φ-ing." Eagle states: "According to this view, X possesses an ability in virtue of the state of a region including X and X's immediate surroundings."[64] These two ways of interpreting 'CAN' claims are supposed to show that CAP is capable with both incompatibilist and compatibilist perspectives on determinism.

The problem for these theories of 'CAN' for Eagle is that they are not flexible enough. The incompatibilist position takes 'CAN' statements to state some kind of truth in the future after the object has or has not Φ-ed. This does not account for the fact the we seem to declare 'CAN' claims to be true even before they Φ.[65] The problem with the latter interpretation of 'CAN' is that it does not capture the appeal of incompatibilism and draws an insufficient

[63] Eagle (2011) 280
[64] Ibid. 281
[65] Ibid. 282

distinction between immediate and other circumstances. The insufficiency of these two accounts leads into Eagle's own "more sophisticated account" based in on work of linguists.

The account that Eagle supports views 'CAN' as an "existential modifier over some collection of possibilities." CAN claims are true if and only if there are possible situations where it Φ-ing is true. But there is still the problem that "can" and "possibly" are not the same, since there are possible situations that cannot happen. This theory gets around this problem by changing the base that is quantified over. For epistemic uses of CAN the base is epistemic possibility. So the 'CAN' in question quantifies over a much larger range of possibility. For our dynamic use of 'CAN' the base is physically or metaphysically possible worlds. The dynamic modal base is much more restricted.[66] There is still some linguistic ways of speaking that escape this explanation and call for greater investigation. An example of this is comes from the work of David Lewis and involves a statement about the ability to speak a language:

I can speak Finnish.

Of course, for most citizens of the world, on first glaze this CAN claim seems to be false. I may be able to my own language or maybe the language of a neighboring country but I certainly cannot speak Finnish. But if we read the sentence as talking about my abilities in relation to a caterpillar that has none of the requisite body parts to even speak never mind a speaking a language like Finnish then it seems true that I can speak Finnish. I just do not exercise this ability because it was never taught to me. This seems to lead to a contradiction. 'I can speak Finnish' seems both true and false. How can this be? Eagle explains this seeming contradiction as an example that shows that statements like these are context sensitive. The truth of these statements is fixed by the context in which they are used in conversation rather than solely by the

[66] Eagle (2011) p.283

constituent parts of the sentence. Context sensitivity fixes the truth value of these CAN claims through background propositions and presuppositions. If I am speaking in a context where people have been talking about the inability of a caterpillar to speak because of the lack of a larynx and then I say something like the aforementioned CAN claim, then it is fixed that I mean that the statement is true in virtue of me having the parts the caterpillar does not have. This leads to what Eagle calls the 'IN VIEW OF' clause. He breaks down 'I can speak Finnish' into two sentences.

a. I can speak Finnish (in view of how my larynx is).
b. I can't speak Finnish (in view of what my schooling involved).

The 'IN VIEW OF R' clause clears up any confusion from the original proposition. Both statements are true so we do not get the strange seeming contradiction that we got in the original proposition. In summation Eagle states his new CAN claim as 'X CAN Φ IN VIEW OF R', which in turn is true just in case there exists a possible world where X Φs while under the conditions in the restrictor R that is, that X's Φ-ing is consistent with the restrictor conditions."[67]

CAP is supposed to represent an integral factor of what it means to be an objective chance. Eagle does not offer CAP as a complete theory of deterministic chance but as a constraint on what an objective chance must be.

II. CAP AND CHANCE ROLES

Though CAP seems to do an explanatory job for objective chances there is one more hurdle for CAP. CAP must now stand in relation to the other principles that characterize

[67] Eagle (2011) p. 284

objective chance. These principles, introduced by Schaffer, are the Realization Principle, the Basic Chance Principle, the Principal Principle the Future Principle, the Intrinsicness Principle the Causal Transition Constraint and the Lawful Magnitude Principle. These are the principles and constraints that are accounts of objective chances must be judged against. Though CAP is not an account of chance it must be consistent with the other principles of chance in order to be included in the list of constraints.

The first hurdle for Eagle is the Realization Principle. The Realization Principle is basically the idea that if there is a positive chance of something occurring than there is a compossible world with the same history and laws in which that event occurs. In other words there is a possible world where that chance is realized. Eagle views this as something that in its wording by Schaffer necessarily leads to incompatibilism between chance and determinism. Instead of flat out rejecting Schaffer's Realization Principle Eagle digs further into the intuition behind the principle. He concludes the CAP and the intuition behind RP are consistent. Relying on the similarity between CAN and POSSIBLE Eagle concludes that the statement in the RP can be read as 'there is a world in which that event CAN happen.' As Eagle discussed before there are two ways view CAN, in one sense as an ability and in the other sense as a logical or epistemic possibility. Eagle concludes that the *possible* in RP though does not allude to which reading of CAN it would read it does not exclude the ability reading that CAP is grounded in.[68]

The Basic Chance Principle is the next principle that Eagle checks to see if it is consistent with CAP. The BCP holds that if there is a positive chance of an event occurring then there is a possible world that matches that the world in which the event occurred up to the time of the event's chance of occurrence. Eagle holds that the BCP and CAP are consistent in a similar manner. In the BCP the present ability of the event to occur is based in its possible occurrence.

[68] Eagle (2011) p. 275

This occurrence cannot be grounded in a merely logical but rather a dynamic reading of 'possible.' The circumstances in the possible world must be similar to the present world in order for the possible world to ground the event's occurrence thus restricting the notion of possibility to the dynamic sense. CAP and the BCP are intertwined to together and share common metaphysical elements.[69]

Eagle reconstructs Lewis' famous Principal Principle in terms of CAP. The Principal Principle links the chance of an events occurrence to the credence in the event occurring. The chance of an event's happening is supposed to fix the credence or belief that the event will happen. Eagle reformulation states as such:

> …things X can do, should constrain our credences in various propositions about what things will do. We should assign no credence to X Φ-ing iff X can't Φ, and we know it can't. This is conjunction with CAP, entails the obvious truth that we should have positive credence in X Φ-ing just in case X has some chance of Φ-ing.[70]

The link between credence and ability Eagle calls the Credence-If-Can principle. This principle states that if one believes that an event can occur than they should have a non-zero credence in the event's occurrence. In conjunction with CAP the Credence-If-Can principle entails that "one's unconditional credence in an outcome should be non-zero if one believes the chance of that outcome is non-zero."[71] This moves into the general statement of the Principal Principle, one's credence in an outcome in conjunction with a non-zero chance should also be

[69] Eagle (2011) p. 276
[70] Ibid. 276
[71] Ibid. 277

non-zero.[72] It seems like there is a possible problem in locating a connection between 'CAN' claims and credence. As a person who only speaks English it seems strange to say that there should be some positive credence in by ability to speak Finnish even though I CAN in the anatomic sense and even though I must have some positive chance in the universalist's universe. Even though it seems strange to say such I think there should be a very minute belief that the individual will speak Finnish that corresponds to the minute chance of the individual putting together a Finnish sentence from the lexicon of sounds and noise that the individual has.

The Future Principle derived from Lewis through Schaffer states that chances are found in the future. In the past there are no chancy events. This principle relies on our beliefs about the asymmetry of time. The statement that 'X can Φ' seems to implicitly imply the Future Principle. Since the past is closed if something can do something that it is not already doing it must do so or fail to do so in the future thus CAP is consistent with the Future Principle.[73]

The intuition behind the Intrinsicness Principle is that the chance must remain the same amongst intrinsically duplicate trials. If the trial is exactly then the chance should remain exactly the same. According to Eagle the same principle is involved here as when we ascribe abilities. When we think of two duplicates under the same exact conditions we ascribe the same abilities to these duplicates. If we have to coins that care exactly the same and placed in the same conditions then they should have the same abilities, behaviors and dispositions.

The Causal Transition Constraint states that chance must be within the transition from one event to another in order for it to have a causal role. If there is a chancy transition between two events then that means that one of the events CAN and did happen. This means there was an intrinsic ability to Φ that causally existed and lead to the Φ-ing. This ability means that the

[72] Eagle also claims that CAP beyond just being capable with PP also provides a strong argument for PP. See 277.
[73] Eagle (2011) p.277

chance between the transition must be positive. Again we find that CAP and another principle/constraint are consistent.

The final principle, the Lawful Magnitude Principle, Eagle bluntly declares that it and CAP are consistent. The LMP declares that if there is a non-zero chance than there is a lawful history to chance conditional. This connects chances to the laws of nature. Eagle states that if the laws are probabilistic and contain chances then chances are as the laws say they are. This means as Eagle states: "CAP then requires that the entities involved have a lawful ability to bring that chancy outcome about, which is obviously right." [74] But the laws of science could of course be deterministic. This again leads us to our original question about the compatibility of determinism and chance, one that will be answered later.

From what Eagle has argued CAP seems to fit in with the other substantive principles of chance. In fact in some cases CAP even seems to strength the other principles. So what are we left with? Eagle's CAP does not provide us with a theory of chance but rather provides us with a new constraint of chance. In conjunction with the RP, BCP, PP, FP, IR, CTC, LMP; CAP now should provide a more complete account of Schaffer's chance substantive. In order for something to be an objective chance it must be able to do the action in question.

III. CAP AND DETERMINISM

While the point of Eagle's essay is not to provide an account of an objective chance he does spend a significant portion of the time showing that CAP provides grounds to have a non-trivialized chance in a deterministic world. In doing this he takes on the incompatiblist argument

[74] Eagle (2011) p.278

for the incompatibility of chance and determinism. Eagle sums up the statement of incompatibilism as:

> If a world is deterministic then no possible outcome in that world has any chance there other than 1 or 0.[75]

What is of interest to Eagle is the phrase 'HAS ANY CHANCE.' When we take into account our discussion of can we can see that 'HAS ANY CHANCE' with CAP entails that that phrase is a "relative modality." 'HAS ANY CHANCE' is grounded by 'CAN' and 'CAN' we have seen is context sensitive. The incompatibilist must hold the position that in all contexts there do not exist any chances other than 1 or 0. Eagle states, "The hardline incompatibilist, remember, has a severe task in front of them: to show that, even though 'HAS SOME CHANCE' is a relative modality, it is never the case that the contextually salient facts permit more than one outcome."[76] The compatibilists on the other hand must only hold that in some context there are chances that are other than 1 or 0. Eagle holds the view that there are such contexts where there are such chances. He argues that our ordinary language implies the existence of chances and that there is no reason to always consider the past and laws to be a relative context to ascertain a chance. In these contexts Eagle expects that the incompatibilist position with be a truth but these are importantly not all of the contexts.

The introduction of context in a discussion of objective chances raises many red flags for compatibilists. But it is important to see how the context that is so essential to CAP does not render objective chances epistemic. There seems something relative about context, in one context the sentence about the object can be true in the other context the sentence describing the object can be false. A person's assertion that I can speak Finnish is true in one sense and false in the

[75] Eagle (2011) p.286
[76] Ibid. p.286

other sense but it does not like it could be an ontological truth. How can I speak Finnish and not speak Finnish? The answer to this problem is that they are two separate propositions with two separate truth values. As stated earlier, 'I have the ability to speak Finnish in virtue of my physiology' maybe be true and 'I have the ability to speak Finnish in virtue of my schooling and learning' maybe be false. What is not changing here is any property, based on language and human interest, the only thing changing is which property and which proposition is referred to.

IV. TOWARDS AN ACCOUNT

Eagle's CAP seems to get us to a place where we can see how objective chances can exists in a deterministic world. The pivotal aspect of CAP is that it seems to latch perfectly on to our intuitions about chance. When we think of the chance of an object doing something or an event occurring we think of a corresponding ability for that event to come about or that object to Φ. We now have a robust vision of chance that introduces the metaphysical notion of abilities into the debate. CAP also allows us to work with notions of context sensitivity and relativity. These new tools seem to help us with the intuitions that in some cases there seem to be determinism and some cases it makes sense to speak in terms of chancy events. It seems as though an account with CAP, with its reliance on language and context with have to make sure not to step over the line into epistemic chances. An account of objective chance will have to be metaphysically robust and CAP in addition to the other constraints gives the framework for a new deterministic chance.

CHAPTER IV

BIRDS OF A FEATHER: PROPENSITIES, DISPOSITIONS and CHANCES

INTRODUCTION

Eagle's Can-Ability Principle (CAP) provides the metaphysical skeleton for an account of chance. It provides a way in which to understand an objective account of chance in a robust non-trivial manner. CAP also shows us what would have to be true in order for an event to have a positive nonzero chance. Positive non-zero chances are grounded in the actual ability for an object to manifest a certain action. CAP connects chances with abilities; it is this crucial link where an account of chance will come from. However, CAP still needs to be supplemented by a metaphysical account of what the relevant kind of ability consists in. In the following chapters I will flesh out an account of chance that links the requisite abilities in CAP to dispositional properties. In this chapter I will critically analyze the dispositional propensity theories of chance offered by D.H. Mellor. After explicating Mellor's propensity account of chance, I will show how his account fares given the current understanding of dispositions. I will continue to show that a link can be formed between abilities and propensities thus wedding CAP and dispositional metaphysics.

I. THE GROUNDWORK

There are several critical elements of the propensity theory of chance. The first elements of this account that are worth analyzing are the ingredients. Propensity theory views chance analogously to a phenomenon being investigated by scientific experimentation. Just as a

scientific experiment tries to capture a phenomenon through systematic testing and experimentation, chances in propensity theory are analyzed as the result of some systematic test. The test is to see whether the objects being tested will Φ and to find the chance of it Φ-ing. The system in which we perform this test is known as the chance-setup. For the event of flipping a coin, the hand and mechanisms of flipping constitute the *chance-setup*. D.H. Mellor echoes Ian Hacking in characterizing "a chance set-up as a 'device or part of the world on which might be conducted one or more trials experiments or observations.'[77] The individual tests of the object are known as *chance-trials*. Take a coin flip for example; the constituent objects are the coin, and the mechanist device for flipping may be someone's hand. The hand represents the chance-setup while the actual flip that occurs represents the chance trial.

On a metaphysical level the propensity theorist sees a strong link between chances, dispositions and propensities. Dispositions are very familiar to us in our common usage. We often analyze behavior in dispositional language, if I am angry person I may be disposed to act angrily (say, punch somebody in the face) in a certain context or with certain stimulus conditions (say, someone insults a family member). But also beyond our own psychological states, we ascribe dispositional properties physical states of objects. A disposition has three major elements which are important to it, the stimulus conditions, the disposition and the manifestation. The stimulus conditions are the relevant conditions that may bring about a manifestation and the manifestation is that outcome. The paradigm dispositional property is fragility. The antique vase sitting in your living room has the property of being fragile. Intuitively we think that this means that if the vase is put under certain stimulus conditions then it will exhibit a manifestation associated with fragility, namely breaking. If I were to drop the fragile glass from a certain distance we expect that it should break.

[77] Mellor (1971) p.67

It is this close relationship between the stimulus conditions and the manifestation that leads to some providing a conditional analysis of dispositions. The simple conditional analysis of dispositions sufficiently and necessarily links the disposition to be analyzed to a subjunctive conditional which explains the disposition. So the statement 'X is fragile' is explained by the conditional 'If X were struck then it would break.' If the object does not break when struck it does not have the disposition.[78]

But as famously noted this is not always the case. Objects like the vase can maintain their disposition even when they do not manifest it in the stimulus conditions. If the vase happens not to break because it is placed in bubble wrap or some wizard imbues it with a protective shield as it makes contact with the ground we still believe that object is fragile. Similarly when I fail to punch an offensive person in the face on one occasion I would still have the disposition to be angry but it was just not manifested at that time. This is called masking. The disposition to Φ in stimulus conditions X is masked but is still there in the object.

Propensities are similar to dispositions. The usage of the term "propensity" in metaphysics and philosophy of science is heavily indebted to the work of Karl Popper.[79] In the literature propensities have a rather vague and loose usage. Popper views propensities as real and objective properties of the world. But they are not properties that are physically visible properties.[80] Popper conceives of propensities as dispositions. They are not exactly dispositions because they can vary by degrees whereas bare dispositions seem all-or-nothing. From their connection to dispositions we can see that Popper's propensities are similar to their common English language usage. These propensities are manifested in single events for Popper rather

[78] This is the view of dispositions that Mellor is working with. As we will see later this simple and rather intuitive view has some problems.
[79] See Popper (1959)
[80] Mellor (1971) p.28

than numerous events. Popper located probabilities and propensities in the single case. The breakthroughs of Quantum Mechanics and the intellectual problems caused by this paradigm shift lead Popper to see that causal role for probabilities and chances. In order for probabilities and chances to play a role causation there had to be something that grounded them with causal potency. This is where propensities come in the propensity theorist. Propensities are taken to have causal powers. Quoting Wesley Salmon (1989) Belnap states: "Propensities, I suggests, are best understood as some sort of probabilistic causes."[81] In addition to metaphysical causal powers propensities are supposed to have explanatory powers. The propensity for an object to Φ in some sense is supposed to explain that object Φ-ing.

II. MELLOR'S PROPENSITY THEORY

Essential to propensity account of chance are this metaphysical groundwork. All propensity accounts use chance-set ups, dispositions and of course propensities. But where the accounts differ are in the location of propensities and their manifestations. D.H. Mellor provides a propensity account of chance which is counter to that of Popper. In explicating his account he begins by analyzing the link between propensities to dispositions.

Despite Popperian argumentation there still seems to be something strange about associating propensities with dispositions. Dispositions are thought to lead to a manifestation in conjunction with certain stimulus conditions. If I was to drop a vase from the Empire State Building and the vase did not break we certainly would not ascribe the disposition of fragility to that vase. A vase that sometimes breaks and sometimes does not in these stimulus, Mellor argues, does not have one disposition of fragility but is rather fragile sometimes and not fragile at others.

[81] Belnap (2007) p.597

But propensities do not work in this manner. It is essential that the manifestation of the propensity is not, as Mellor puts it, invariable. If, when a coin is flipped and it always lands heads it seems preposterous to say that it had a propensity to come up tails. Also since propensities work by degrees and are not all-or-nothing they seem to be inherently variable.

This leads to a dilemma. If dispositions manifestations are invariable then "either [a] propensity is not a disposition or results and outcomes of chance trials do not display it."[82] Besides dispositions, another concept that a propensity could be are tendencies. Tendencies and dispositions are similar but dispositions seem to be stronger in the sense that they more strongly connected to the object. Tending to behave in a certain way is less strong having a disposition to act that way because not exhibiting the manifestation does not imply the tendency is not there. The only thing that would imply that the tendency was not there was if it not performs accordingly in the preponderance of trial run. What this boils down to is that tendency is a statement that the manifestation an object will behave in a certain way more often than not. For Mellor the problem of explaining propensity and chance in terms of tendencies is that is does not explain anything. To define chance in terms of propensities and then in terms of tendencies is circular. A statement that x has a tendency to A in C requires that there be some probability or chance that x will A in C because saying x has a tendency to A in C means the same thing as it is more probable that x will A in C than not A in C. The coin has a tendency to flip heads if it is more probable that it will flip heads or it has a higher chance of flipping heads. We are left explaining chance with chance.[83] Being that the only other candidate for what a propensity could be fails Mellor takes the second route and maintains that propensities are dispositions but they do not occur in outcomes.

[82]Mellor (1971) p. 69
[83] Ibid. p. 70

From the account of propensities, dispositions, and chances and their relationship to each other Mellor lays out his positive account of what a chance is. It is already evident that he believes chances to be dispositional properties and more specifically propensities. There are two important parts to Mellor's propensity theory of chance; one part is the *what*- what has chances- and the *where*- where the propensities manifests.

There are two candidates for the holder of propensities. The first candidate is the chance-setup. Philosophers including Popper and Hacking hold chance propensities to be properties of chance-setups. The other candidate, favored by Mellor, is that propensities are properties of the entities involved in the event itself. For flipping a coin, proponents of the chance-setup account would state that the flipping mechanism, say the thumb placed in a certain manner and the whole system affecting the coin's outcome has a certain chancy propensity for a manifestation. Mellor and the proponents of the entity view of chance would contend that objects in or undergoing the test of the chance set-up have the chances- so in the coin flipping case it would be the coin that holds the chancy propensity. Mellor contends that the previous view conflates propensities and chance and claims that this leads to the proponents' misattribution of chances to chance-setups.[84] Mellor also provides an independent metaphysical reason for rooting chances in entities. He very clearly and concisely states his argument for his position. He states that scientific conventions pick out entities to assign properties to and objects are more real than complex chance setups. This is a mixture of an argument based in the practices of science and the practices of metaphysics. The attribution of properties to chance-setups would require that these chance setups exist as ontological entities just like coins and normal objects. For Mellor the problem is that in order to make sense of propensities in chance-setups we would have to add chance-setups to our ontological tool-box. Not only does this seem intuitively strange there also seems a much

[84] Mellor (1971) p.71-74

more simple account.[85] Intuitively and scientifically we attribute properties to "permanent entities." We say that salt has the property of being soluble in H_20 rather than the laboratory equipment in conjunction with the salt has the property of being soluble. Another argument for attributing chances to permanent entities that Mellor does not pursue is that there is a sense in which we can say that objects have properties like chances and propensities minus any chance-setup. If chances are located in chance-setups then it makes no sense to speak of the coin on the table having a chance or anything having a chance unless it is accompanied by a chance-setup putting it under stimulus conditions.

After Mellor places chances in the coin he must now explain where these chancy propensities manifest in these coins. There seem to be two options for Mellor. Either the manifestation of chancy propensities can be found in the object Φ-ing or they can display themselves in the chance distribution. Mellor favors the latter. He states clearly, "The display of a propensity is the chance distribution over the possible results of the appropriate trial."[86] The chance distribution refers to roughly the chance that the object should manifest rather than the outcome itself. This means that manifestation of the coin's propensity is that it flips with a 50% of coming up heads and a 50% of coming up tails. An example Mellor uses of propensities' displays is as follows:

> The display of a propensity or of any other disposition is not normally a chance matter. It can be made so, however, if for example we decide to toss one unbiased coin, a, only if another, b, that we toss lands heads. Otherwise *a* is to be turned tails up. We can make a machine do all this when we press a button, and the

[85] Mellor (1971) p.74
[86] Ibid. p. 74

> chance then of a landing heads is 1/4, of it landing tails ¾. That indeed displays a propensity in the machine…[87]

Dispositional invariability is important for Mellor. As was discussed earlier the dispositions without finks or masks should manifest themselves. But is this the case with Mellor's dispositional propensities? It seems as though a fair coin will always have a ½ chance of coming up either heads or tails.

III. PROPENSITIES AND CAP

Now that we have excavated a propensity theory of chance it is essential to see how this theory relates to the larger debate on the compatibilism of determinism and chance. The Chance-Ability Principal provides the link that a non-trivial chance will need. In order for a coin to have a chance of flipping heads it CAN flip heads and must have the *ability* to flip heads. We have already seen how propensities, dispositions and chance are interlinked on Mellor's account I will now throw abilities into the fray in hopes of linking the propensity account of chance to CAP.

Dispositions and abilities seem to be very close relatives. Just like with dispositions, abilities seem to remain hidden until put in some stimulus conditions yet this hidden aspect does not mean that they are not there. We can see that there is an even stronger link between dispositions and abilities. When an object has a disposition to Φ it also has the ability to Φ likewise when an object has an ability to Φ then it has some disposition to Φ.[88] When I am disposed to lie in certain stimulus conditions then I must also have the ability to lie in those

[87]Mellor (1971) p. 72
[88] Fara (2008) p. 844

stimulus conditions. Dispositions seem to supervene on abilities.[89] The other direction also seems to work in a similar manner. If I have the ability to make a 3-pointer then there must be some stimulus conditions where I am disposed to a make a 3-pointer. Contrarily mask only work in one direction. Michael Fara argues that if an object's ability is masked then its disposition is masked as well. The relationship seems not to work in the opposite direction. If my disposition is masked there is still a sense in which I could have the ability and act with the ability while not being disposed to. For example if my disposition to speak French when spoken to in French to was masked there still seems to be a way that the ability is still there.

Propensities are intimately related to dispositions and dispositions are grounded by abilities but how are propensities and abilities related? Propensities, in the way that Mellor uses them, seem to also supervene on an ability to Φ. Propensities are supposed to have some causal powers and in the Popperian sense are supposed to be 'real' like the Newtonian gravitational forces. If I had a propensity to Φ, in the same way as if I have the disposition to Φ, I must have the ability to Φ. This seems to also simple follow from the fact that propensities are a type of dispositional property. All dispositional properties must have an ability to manifest themselves in the appropriate conditions as long as no finks or masks are present, propensities are types of dispositional properties so it follows that objects with propensities must have the corresponding abilities.

As we have seen any account of objective chance in a deterministic world will have to be consistent with the Can-Ability Principle. CAP being the principal- that is if something has a nonzero chance of occurring then it CAN occur, where CAN is understood as the ability to occur. As our metaphysical linkage shows propensity theories like Mellor's seem to be perfectly

[89] When I say supervene I do not mean that all properties of dispositions supervene on abilities. Rather I mean the existence of dispositions supervene on the existence of abilities.

consistent with CAP and even seem to flesh out and explain CAP better.[90] If objects like coins have propensities to flip a certain chance distribution, 50%, then it clearly CAN flip with a 50% chance distribution. What makes it true that the coin has the propensity to flip with a 50% chance of coming heads is that it has the ability to do so.

What the propensity theory of chance does for CAP is provides a theory of chance. CAP and the propensity theory of chance are consistent but where CAP stops short is actually proposing a theory of chance. It posits that chance and ability must be linked but does not posit how they are linked. We can see that they are metaphysically linked through these dispositional properties called propensities that reside in objects.

IV. MELLOR'S FLAWS

There are three major problems in linking Mellor's account of chance with determinism. The first problem is that Mellor believes that the existence of working propensities precludes the truth of determinism. He states, "If propensities are ever displayed, determinism is false."[91] This obviously does not fit in with the intuition and the goal of CAP, which is to provide a principle that can make sense of objective chances in a deterministic world. In that sense it seems problematic to use a theory that assumes chances must be indeterministic to explain deterministic chances.

a. Determinism, Propensities and Chance

In a latter discussion about the role of chances in the causal link Mellor restates the propensities are inconsistent with a deterministic except in what he calls in a "frivolous" sense.

[90] Mellor believes that propensities and determinism are incompatible but I will address this later.
[91] Mellor (1971) p. 151

This case is where there is an un-flipped coin. He declares it is consistent with a deterministic world that the un-flipped coin would have a propensity in the coin but not have a chance.[92] But this is weak relationship between chance and propensities are problematic for Mellor's account. There must be a stronger link to make sense of chance. Mellor's dispositional account of chance is supposed to be an exhaustive account explanation of chance. If propensities share only this weaker relationship as Mellor seems to assume there can exists cases where there are propensities without chances and more importantly chances without propensities to serves as their grounds. In these cases we are left with an explanatory gap. To arrive at this problem let's look back at Lewis' maze example. There is a chance of me completing the maze by noon and let's say I have a propensity to reach the end of the maze. Say I lose the propensity to reach the end of the maze; I am paralyzed and lose my vision. There still remains a chance that I reach the end of the maze by noon if propensities and dispositions are weakly linked together as Mellor declares that they are. There is a chance a hurricane could come along and blow my paralyzed blind body to the end point but the chance diminishes as time continues to noon. What we have in this situation is a chance without a propensity and a problem for Mellor's dispositional account of chance. With a stronger connection between a chance located within the trial and propensities the change in propensities can explain the change in chances that we expect. Otherwise if the chance cannot be located in the trial the chance cannot change or reflect any changes in the propensity. On Mellor's account we are either left with a floating chance or an unresponsive chance, both of which seem unacceptable. In relation to determinism we must still explain how this chance-propensity relationship works with deterministic laws.

[92] Mellor (1971) p. 156

b. Chance Distribution

Mellor roots propensities in the display of chance distributions. Even though this is a chance distribution, it has a metaphysical ring of mysterious around: it seems as though Mellor is proclaiming that objects have a propensity to Φ at a certain chance rather than the alternative that objects have a propensity to Φ. The coin's disposition has been manifested when it flips with a 50% chance of landing heads. The problem with this view is that there seems to be a gap between at the relationship between the chance distribution and the outcome.

There are problems that come from stating that the manifestations of propensities are chance distributions. The first of these problems is that if this were the case these propensities would be completely inconsistent with other dispositions and propensities. The manifestation of dispositional properties is always thought as the object Φ-ing. The fragile glass displays its fragility when it breaks when dropped at a certain height. My disposition to speak French is manifested when I actually speak French in the appropriate stimulus conditions. Dispositions work in this manner and propensities as dispositions should follow the same suit. Mellor's propensities manifest in a strange and vague way. Not only is it inconsistent with the way that other dispositions manifest, this inconsistency seems to be at due to another problem in Mellor's account. Dispositional properties are thought of to be objectively real. It is consistent with this view of dispositions that they manifest themselves in real ways, with actually occurring objective events. Chance distributions do not have the ontological realness that events have. Rather chance distributions seem to be mathematical devices with no reality or a reality fundamentally different than the disposition that they are the manifestation of.

Mellor's account of chance distributions has problems reaching the outcome of the chance trial. The outcome of the coin flip seems totally irrelevant to the chance and the propensity. But

it seems totally absurd to say that the outcome of a chance trial has no relation to the chance propensity. But how does Mellor make the outcome relevant? It seems as though there is no way for him to connect the chance distribution to the outcome and to have a meaningful chance outcome.

c. Finks and Mask

The last problem for Mellor's account is that it predates writings on finks and mask. Though I mention finks and mask briefly, I purposely skirt the issue of finks and mask in explaining Mellor's account. We can see the influence of finks and mask in Mellor's discussion of dispositional invariability. Since he holds dispositions to be invariable he holds that they almost strictly follow the conditional analysis of dispositions. Mellor's view of dispositional invariability leads him to argue that chances must be in chance distributions. Finks and mask cast doubt on this analysis of dispositions. They show that dispositions are not as invariable as they seem in fact there are cast where if they are put into their stimulus conditions they may still not manifest.

CONCLUSION

As it stands now Mellor's account has some major problems standing in the way of it being considered a successful account of chance. But there are many positive aspects of Mellor's account that can be salvaged. There is strong reason to believe that chances are related to dispositional properties, and propensities. Similarly we see a promising link between a dispositional account of chance and the Can-Ability Principle. The remaining chapter of this

these will be devoted to a reworking of Mellor's account to provide a new dispositional theory of chance.

CHAPTER V

OBJECTIVE CHANCES IN A DETERMINISTIC WORLD

INTRODUCTION

While Earman proclaims that determinism is a philosophical topic par excellence the work on deterministic chances has shown that many excellent conundrums arise from the implications of determinism. The possibility of a deterministic or partially deterministic world seems to cause problems for our notions of objective chance. In this thesis we have seen that in order to have an objective chance there are certain chance constraints that each candidate must adhere to, to which most of the candidates fail. I have also argued that Eagles CAP must be put into the pantheon of chance constraints. In trying to flesh out an account of chance from these constraints I relied on Mellor's dispositional account of chance. But this account of chance is not without its flaws. In this chapter I will provide a dispositional account of chance which overcomes the flaws of Mellor's model.

I. A NEW DISPOSITIONAL ACCOUNT OF CHANCE

Mellor's account is full of problems but it is not unsalvageable. In the following section I will provide my account of chance which will hopefully take care of the problems of Mellor's. In my account I will focus on keeping fundamental elements of Mellor's account. My account will hold that chances are dispositional properties and give more metaphysical flesh to a dispositional account of chance. I will critically differ with Mellor on the other issues like the relationship between chances and dispositions and the manifestation of chancy dispositions.

a. Grounding

Dispositions are properties came under attack famously from Gilbert Ryle. In *The Concept of the Mind* Ryle argues that dispositions have an occult like status. What he means by this is that they seems to not be real properties of objects but rather ghost like entities that are associated with objects. More recently, philosophers have tried to take the occult aspect out of dispositions by finding grounding for them. Dispositions are also thought to have a causal element to them; this again calls for a deeper look into the base of dispositions. It is widely, although not universally, accepted that dispositions are grounded by categorical properties. Categorical properties are brute physical properties like chemical structure. There are at least two ways at arriving at the conclusion that categorical properties ground dispositional properties. The first way is to argue that there can be glasses that are fragile and glasses that are not fragile. What must account for the differences in these glasses is some sort of difference in their physical make up. It makes sense to say one glass has a different chemical bonding and this is why it does not have the disposition. Now there may be second order dispositions but it seems that somewhere on the fundamental level there must be a physical base that grounds the dispositions. Another argument centers on the causal relevance of dispositions. If dispositions are supposed to be somehow involved in causal chains and these causal chains involve physical properties then it seems as though there must be physical bases that are involved in the causal chain. The crystalline structure of sugar is causally relevant to its dissolving in water.[93] These arguments are made by those who favor what is called a realist position on dispositions.[94] These arguments seem to be consistent with our scientific thoughts on causation and ontology.

[93] Mackie, J.L. Dispositions, Grounds and Causes and Armstrong Dispositions as Causes

[94] There are some realists who do not hold this position and hold that there are only dispositional properties. Like Bird (2007).

If chances are to be thought of as dispositional properties or propensities which I believe that they should be, then they must also have a physical base. Deterministic chances seem to be perfectly grounded by their physical structure. Let's take the example of the fair coin that is going to be flipped. The coin has two equally weighted sides. This corresponds to the chance that we give the coin. Since there are 2 sides the chance that it flips on one of those sides is ½. The same thing goes for a die. The die has 6 sides so the chance of landing on any of those sides is 1/6. Deterministic chances supervene on the physical properties of the objects that have them. These physical properties like the structure of coins and dice serve as the categorical bases for the dispositions.

Though the connection between physical structure and chances seems airtight it may be argued that on the quantum level there are chances yet there are not physical categorical properties to ground these chances. It is thought that particles at this level are just categorized by bare dispositional properties like spin, and indeterminate locations. This objection is sound and does raise a problem. I answer this objection through drawing a distinction between pure chances and deterministic chances. On the quantum level it makes perfect sense to just have pure chances but deterministic chances must have a physical base.

b. Chances as Dispositions

The link between deterministic chances and categorical properties shows that objects can have chances to do certain actions even before they are put through any type of trial. The coin has a .5 chance of flipping heads even before it is flipped. One can arrive at this fact by merely inspecting the physical structure of the coin. The coin has two equally weighted sides therefore there is a 1 out of 2 chance that it will land on one of those sides when flipped. Since chance is parasitic on this physical structure we can say that this chance is an intrinsic property of the coin.

The chance of flipping ½ is a property the coin has just in virtue of its physical make-up. While chances like these are intrinsic to the object not all chances are intrinsic. Chances that involve multiple objects are not intrinsic. The chance of one coin flipping heads when it depends on the outcome of another flip is an example of an extrinsic chance. Chances that are not directly connected to the physical make-up of the object are also extrinsic. Lewis' maze is an example of an extrinsic chance that the agent has to reach the maze by noon.

Intrinsic chance dispositions are properties of entities. All entities have a chance of performing some type of action inherently. The die inherently has a particular chance namely $1/6^{th}$ of rolling a six if rolled and, as stated before, this is due to its physical structure. Physical structure is important in grounding chance it tells us that there are intrinsic chance properties but we still have no account of how these intrinsic chances work as dispositions. There are two options for the type of dispositions that chances could be. Either chance dispositions could be one disjunctive disposition or what Alexander Bird calls a complex single track disposition or multiple single track dispositions.

On all accounts the die has a disposition to roll six and a disposition to not roll six. The question is merely where to be this other disposition. On the complex single track account instead of viewing the disposition to not roll six and the disposition to roll six as separate surefire dispositions we can see these dispositions as something close to a multi-track disposition. Surefire dispositions are those that are very closely related to the dispositional conditional analysis of dispostions. The conditional analysis of dispositions states that and object has a disposition to X iff in certain stimulus conditions S, X were to manifest. Surefire are dispositions like fragility that when they enter a stimulus condition necessarily (so long as there are not finks or masks around) manifest. When the glass is dropped at a certain threshold length in the

absence of interfering factors it must break or else it is not fragile.[95] Multi-track dispositions are different in the sense that they can have different stimulus conditions and different manifestations. Bird and Ryle explain how knowing French is a multi-track disposition. There are multiple ways in which knowing French can be manifested. It can be manifested through writing in response to one stimulus or through speaking in response to another stimulus. As Bird notes certain multiple-track dispositions may be better noted a complex single-track dispositions.[96] These are dispositions with one stimulus and multiple manifestations or one manifestation and multiple stimuli. Take the flipping of a coin. If I flip the coin in stimulus conditions S it seems like chance requires two manifestations the coin flipping heads and the coin not flipping heads. Whether these chances are multi-track or complex single-track dispositions they involve one stimulus condition with multiple manifestations combined by an exclusive disjunctive. The chance for the coin to flip heads is actually a complex disposition that involves under the same stimulus conditions the manifestation of it not flipping heads.

But there is a problem for this view. The single complex disposition cannot differentiate between a biased coin and unbiased coin. In this sense we do not yet have chance. The disjunctive put equal value on all of the disjuncts, either it can flip heads or tails. But the problem is that in a bias coin and in other chancy events one option is weighted heavier. The disjunctive relationship is not sufficient to characterize chance there must be something indicating the strength of these manifestations. It cannot be that the other manifestations are masked because there is still a way that even though it is biased toward one manifestation it may very well come up. The only option seems to be to appeal to the mythic chance distribution that we rejected as

[95] Again this is minus finks and masks.
[96] Bird, Alexander Nature's Metaphysics 18

too vague and ontologically unreal. The manifestation's strength would have to be based on some stronger chance that it occurs based on the bias.

There is another option for chances. It could be the chance that an entity like the coin has two separate single-track dispositions. The coin would have the single-track disposition to flip heads and likewise a separate single-track disposition to flip tails. Similarly the die would have 6 separate dispositions corresponding to its sides. The dispositions would all have to have the same stimulus condition yet remain distinct. If the coin had different stimulus conditions then it would be obvious that if the coin would have different manifestations. This would of course be be counter to our whole project. We so far have been striving to figure out how something that could genuinely have numerous manifestations from one stimulus condition can be consistent with chance. Objective chances seem to presuppose the same stimulus conditions.

This option faces two problems. The first problem is that adherents must argue that even though the stimulus is the same that the dispositions cannot be reduced to the disjunctive statement. Adherents of this view must also explain how the dispositions work with each other to create what we know as a chance. Since the metaphysical problems for chance distributions are deep. The best option is to the latter despite the question of whether it reduces or not. If we assume that it does not then we still have the question of how it grounds chances in a deterministic world. This question will serve as the focus of the rest of this chapter.

c. Manifestations

For the reason stated throughout these last two chapters I have argued that the manifestations of chances are not chance distributions or connected to chance distributions in any ontological way. Chances as dispositional properties must manifest themselves in real ways; the way that I

have hinted at is through the outcome of the chance trial. The manifestation of the chance to flip heads is the coin flipping heads; the manifestation of the die rolling six is the die rolling six, etc. This allows chances to be rooted in something more concrete and metaphysically strong.

d. Account

Putting the pieces together we get that chances are dispositional properties. Specifically they are single-track dispositions. I have argued that deterministic chances have intrinsic dispositional properties based in nothing more than their physical structure. The coin intrinsically has a chance of flipping with a .5 chance of coming up heads. This means that the coin has a disposition to flip heads and a disposition to flip tails. Unlike Mellor I centrally located the manifestation in the outcome or the objects' Φ-ing rather than the chance distribution.

II. THE SPECTER OF DETERMINISM

With an account of chances as dispositions in place the task remains to show how this account is capable with determinism. In its most basic sense determinism is the thesis that the state of the world supervenes, or is determined, by the previous state of the world in conjunction with the laws of nature. I have explained that Eagle's Chance Ability Principle provides us with a useful way in which to see how objective chances can remain in a deterministic world but I have also explained how this while being useful is not an account of objective chances. In the following section I am left with two burdens show how my account in a (*a*) strengthening of CAP and (*b*) show how this account is consistent with determinism.

a. Dispositional Account of Chance and CAP

CAP restated is:

> **The Chance-Ability Principle** (CAP)
> Where X is a noun phrase, and Φ a complement verb phrase, the chance of X Φ-ing exceeds zero iff X can Φ. (Similarly, as 'MUST' is dual to 'CAN', the chance of X Φ-ing is one iff X must Φ.)[97]

CAP makes the distinction between trivial chances and objective chances by taking into account whether the objects CAN actually do the action in question. This CAN claim is linked to an ability to do the action. What makes the coin have a chance of flipping heads is that it has the ability to flip heads or it CAN flip heads. What makes it the case that it has a chance of flipping tails is likewise that it CAN flip tails. On my dispositional account of chance what grounds the chance are the single track dispositions. This seems to at first be at odds with CAP. CAP's chances are grounded in abilities while my chances are grounded in dispositions. But as we have seen before this distinction is misleading. Dispositions and abilities, I have argued, are necessarily linked together. X has the disposition to Φ iff X has the ability to Φ likewise X has the ability to Φ iff it has the disposition to Φ.

The account again grows more complex and metaphysically stronger. Objects with chances have both dispositions and abilities to Φ. The coin that is flipped has a ½ chance of flipping heads because it has a multiple track disposition to flip heads and to not flip heads. Objects like the coin also have a corresponding ability to flip heads and not to flip heads. With CAP as merely a constraining principle Eagle is not able to explain why chances have these abilities. The dispositional account of chance that I am positing shows the connection. Chances

[97] Eagle 272

are abilities because they are dispositional properties. The ability ascription that Eagle gives to chances is actually paired with an account of chance that makes sense of the ability involved. CAP is not capable with my dispositional account of chance but is also bettered by this account.

b. Determinism

It can be argued that despite the connection with CAP it still does seem as though my dispositional account of chance provides an account of deterministic chance. The notion of a numerous dispositions with the same stimulus conditions seems to be inherently indeterministic. Determinism requires some level of unique evolution. This constraint of unique evolution seems to mean that one stimulus condition gives one unique result. If I were to put the object into that stimulus condition then I should get the same result over and over again. This is exemplified by the pendulum. Swung in the same exact way I should get the exact same outcome, mainly the same motion. The single-track dispositions at the root of chance seem to contradict this principle. Instead of one unique outcome the entity in question can manifest its self in multiple different ways from the same stimulus conditions. If I were to flip the coin in the same way the two single-track dispositions with the same stimulus conditions makes that the coin could manifest by an outcome of either flipping heads or not flipping heads. In a deterministic world I should see the same result from the stimulus conditions with an equation like necessity.

A solution to this problem hinges critically on the distinction between the laws of nature and properties. A way to show the two are compatible is to assume that (1) laws of nature are metaphysically real, (2) assuming them to be deterministic in the deterministic world we are considering and (3) to be separate from the local properties of objects. What happens in the case of chances in a deterministic world is that the laws of nature, like the laws regarding the motion

of entities etc., work to mask the other possible manifestations. In other words, the property and ability to do otherwise remains in the object; it is merely masked by deterministic laws that control which outcome manifests. This, of course, relies on the three assumptions of the laws of nature that I have laid out. There are accounts of laws of nature where laws are nothing more than regularities that have no real power; such laws could not work to mask chance dispositions. The laws of nature that are required to make this account work *must* act on entities. The laws of nature must be separate from the properties that make up the entities. With this separation we can see how we can have a seemingly indeterministic property in a deterministic world. However if the laws of nature are determined by the relations of local properties in individuals then it would be impossible to have this relationship. Also this account requires that the laws of nature are not part of the stimulus conditions. In order to get around this problem I will have to rely on a restricted version of the stimulus conditions. The stimulus conditions with have to be relegated to simply the direct appropriate entities used to bring about the manifestation. In the coin example the stimulus conditions are the flipping of the condition with an appropriate flipping mechanism.

This is an account of chance that is compatible with a deterministic world with deterministic laws. The object still has the ability to flip heads and tails as well as the single-track dispositions regardless of the deterministic laws. The incompatiblists claim that in a deterministic world chances other than 1 or 0 do not exist. In one sense they are right but in another sense they are wrong. When the deterministic laws are taken into account and they exercise their power on entities there are no chances other then 1 or 0. But this is a misguided view as I have argued objects have intrinsic chances based on categorical properties like their physical structure. These objects have chances that are not necessarily 1 or 0. In the deterministic world we can still look at the coin sitting on the table and make the correct statement that it has a

½ chance of flipping heads. As with the context sensitivity discussion the referent changes yet the property the chance that the coin has remains the same. The chance of the coin flipping a certain way in virtue of the deterministic laws is either 1 or 0 the virtue of it flipping either way in virtue of its make-up is .5. The former represents an extrinsic chance and the latter represents and intrinsic chance and they are both compatible in a deterministic system.

III. RADIOACTIVE DECAY

So far I have used example of coin flips and dice rolls to bolster my account of chance. I turn now to giving a very basic account of the dispositional theory of chance with half-lives and radioactive decay. Radioactive decay is the process of an unstable atom losing its ions. Intuitively we think that if an atom loses half of its ions in one hour it should lose the next half of its atoms in the next hour. This is not necessarily so rather, on the individual level atomic decay is unpredictable. Radioactive decay is intimately related to randomness and probability.

Explaining radioactive decay with my dispositional theory of chance I must start out with the unstable atomic nucleus. The unstable nucleus has a chance of emitting X amount of particles in a certain timeframe. This chance can be further explained by the nucleus's disposition to release X amount of ions in timeframe T and thus a corresponding ability. There are numerous single-track dispositions that correlate to the release of an different amount of atoms, which essentially leaves the numerous amounts of ions open to be considered the manifestation. Regardless of whether there are deterministic laws or probabilistic laws actually governing the decay at the higher level at the lower level the atomic nucleuses still have these intrinsic chances to release a certain amount of ions in a certain period of time. Multi-track and single-track

dispositions in general may help to explain the existence of randomness on lower individual levels while having determinism at higher global levels.[98]

CONCLUSION

By looking at the problems with Mellor's dispositional theory of chance I have provided a better account of how dispositional properties ground chances. On my dispositional account chances are composed of complex single-track dispositions. These dispositions are intrinsic to objects based on their physical categorical properties. When we consider how extrinsic factors influence these properties we see how determinism and objective chances are compatible. Deterministic laws work to mask the other possible manifestations that to do not manifest. This means that chances other than 1 and 0 do exist in a deterministic world but not when we consider the deterministic laws acting upon these objects.

[98] This is assuming that radioactivity has some short of physical base that is relevant to its behavior. If this is true than I think my account suffices to explain the chance. If it is not true, as it may certainly be, I think that the chance here is a pure indeterministic chance.

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